THE

POPULAR SCIENCE MONTHLY.

DECEMBER, 1893.

THE STORY OF BOB.

By DAVID STARR JORDAN,
PRESIDENT OF LELAND STANFORD JUNIOR UNIVERSITY.

WE called him Bob. We never knew his real name. That had been left in the jungles of Borneo. He was born in 1890, a prince of the tribe of *Cercopithecus* which inhabits the palm forests of the south sea islands. Stolen from his parents by a south sea trader, he was brought to San Francisco, exchanged for a keg of beer, and found his way at last to a Kearny Street curiosity shop.

Not long after, a student of evolution saw him there, ransomed him by a subscription from his fellow-students, and Bob was transferred to a new home in the university beside the Tall Tree. Here he was placed in the custody of a young naturalist from Japan. Otaki being likewise Asiatic by birth, understood the wants and feelings of Bob better than did any of the others by whom he was surrounded.

We first knew Bob as a wild and suspicious creature, who looked at all who came near him with fear or hatred. If any person touched him, Bob would look him straight in the eyes, with scowling face and lips rolled back, every muscle tense for action in case of any injury or indignity. Whenever he was lifted from the ground, all these expressions would be intensified; but he never ventured to bite any one who seemed beyond his size, or to escape from any one he thought able to hold him. Toward women he showed from the first great aversion, for they had poked him in the ribs with their parasols while he was in prison in Kearny Street. Furthermore, he seemed seriously to disapprove the unseemly freedom allowed to women in our country.

In such matters, our manners and customs are very different from those which prevail in the tribe of *Cercopithecus* in Borneo.

After a time, under protest, he let one young woman lead him about by his chain, and refrained from open enmity; but he never gave her either trust or affection. Children he held in utter abhorrence, for it was their delight to ridicule him and to vex his dignity with sticks and clods of earth. When any of them came near him, he would jump at them, hissing and scolding, and often only the strength of his chain saved them from injury.

Bob and the Napa Soda.

When Bob came from Kearny Street his hair was infested with the small, louse-like parasite (*Hæmatopina quadrumanus*) which always abounds where those of his race are gathered together. Bob did not try to conceal this fact; he made it the joy of his leisure. A large part of his time was spent in searching his arms and legs in quest of the insect. When he found or pretended to find one, he would eat it with much appearance of satisfaction, keeping up all the while a vigorous smacking of the lips. A young entomologist became interested in this, and sought to make for himself a collection of these insects from Bob's hair. But while he made his explorations, putting his captures in a small vial, Bob conducted a similar search among the hairs on his friend's hand. The bystanders laughed heartily, but Bob saw nothing funny about the affair. If one could judge by his movements and the smacking of his lips, he was more successful than the naturalist himself. But all this with Bob was simply an excess of politeness. In his tribe of *Cercopithecus* it is the height of courtesy for one individual to go over the head and

shoulders of his friends, taking hold of hair after hair, drawing them through his fingers, so that no parasite can escape. If a stranger in any way earns his good will, Bob will show it by devoting himself to this search either on hand or coat sleeve. At these times Bob is the perfection of courtesy. He pretends to find numberless *Hæmatopinæ* on his friend's hands, even though you can see with your own eyes that he finds nothing at all. And all the time he chuckles and smacks his lips as though each discovery were an object of personal satisfaction to him.

Of snakes, large or small, Bob has always stood in abject terror. If he is held firmly and the snake is placed near him, he looks piteously in the face of his keeper, and sometimes, more in sorrow than in anger, he will bite if he is not let go. At one time a snake in a paper bag was shown him. When the paper bag was afterward left near him, he would furtively approach and open it, to peep a moment shiveringly into its depths, and then retreat ignominiously, only to approach for another peep when he had summoned sufficient courage.

A live salamander was placed on the table by his side. This he looked at with a great deal of interest, finally taking it in his hands, with many precautions. When he saw how inert it was, he laid it down and lost all interest in it.

Toward a flat skin of a coyote and one of a wild cat, used as parlor rugs, Bob showed the same fear as in the presence of the snake. If one brought them near him he would jump wildly about or cower in terror behind a chair. This instinctive fear is apparently an inheritance from the experience of his fathers, whose kingdom was in the land where tigers and snakes were dominant and dangerous. A similar skin without hair and eyes he cared nothing for. At one time he climbed on the back of a chair to get away from the coyote skin. The chair was overturned by his efforts. He saw at once that when the chair fell it would carry him backward to the coyote, so he let go of the chair and, seizing his chain, swung himself off out of the reach of the coyote, while the chair was allowed to go over. This was repeated afterward with the same result.

Bob grew very expert in the use of this chain, which he came at last to regard as a necessary part of his environment. In climbing chairs or trees he always took it into consideration. He never learned to untie knots in it, but would very deftly straighten it whenever it became tangled or kinked. Sometimes he would break fastenings, escaping to the top of the house, clanking his chain as he went. It was not easy to catch him then, for he delighted in freedom. At such times he would manage the chain most skillfully, going back to set it free if it caught on any projection. When very hungry, however, he

would come down to the ground or sit patiently outside the kitchen window, waiting to be coaxed and caught. At one time, after we had been entreating him for an hour, he came down from the house in a rage to scare away some boys who were mocking him from below, and who fled in terror at his approach. When loose in the tall grass, Bob would walk on his hinder limbs, holding his head high, and looking about for birds, in whom he seemed to take much interest. For some reason their calls attracted him. His hands meanwhile were held with drooping wrists like the wrists of persons afflicted with the Grecian bend. Toward most animals and toward persons he could not frighten he usually affected perfect indifference, often not deigning to grant them even a glance.

After Claret—Katzenjammer.

Toward horses and cows, and to other animals "big and unpleasant" to him, he held a great dislike. When Billy, the saddle horse, came near him, Bob would crouch like an angry cat, erecting his hair, humping his back, and scolding vehemently. When in his judgment he was safely out of Billy's reach, he would advance boldly and scold loudly. When he thought Billy too near, he became as small and inconspicuous as possible, to avoid the horse's notice. At one time he was placed on Billy's back, where he went into spasms of fear. When taken into the house, he grew bolder, and, climbing on the back of a chair, he described his adventures volubly and with many gestures to his friend Otaki, who understood it all.

To the big dog Rover he also had strong objections. Rover looked down on Bob with tolerant contempt, as a disagreeable being, not to be shaken like a rat because possibly human. But

when Bob would strike him in the face with the flat of his hand, Rover would snap at him, barking indignantly; but he never caught him, and Bob was careful to keep out of his reach. His discretion could be counted on to get the better of his courage. With the little terrier, Dandy, Bob's relations were often friendly, although there was very little mutual trust. At one time Dandy was deep in the ivy in search of a rat, while Bob had also entered the ivy by another opening for other reasons. They met in the dark in a rat-hole through the ivy leaves, and a sharp conflict ensued, marked by much scolding on the one part and pulling of hair and barking on the other. When Dandy had dragged Bob to the light, both were very much surprised, and they parted with mutual apologies and much shamefacedness.

In Devotions.

Being offered a glass of milk, Bob looked at it for a moment, then took the glass in both hands and drank from it. His mouth being small, much of the milk was spilled on the floor. Being then offered a glass partly full, he handled it more deftly, seeming to understand how to use it. When offered a pewter cup with a handle, he took it in both hands and drank as from the glass, but, noticing the handle, he set the cup down and raised it again properly. Then he drank from it as a child of any other race would have done. He soon learned to drink water from bottles. If the bottle were large, he would use one of his hands to hold it, guiding it to his mouth by his hinder legs. At the first trial he understood the purpose of the cork, which he would draw with his teeth. Then he would look down into the neck of the bottle to see if the water were really there and no deception practiced on him. He also usually shook the bottle before drinking, apparently a custom in

Borneo. Once a bottle of carbonated mineral water ("Napa soda") was given him. He drew the cork, much surprised at the explosion, and the character of the water caused him equal surprise; still he drained the bottle and was apparently pleased with it. A bottle of claret being offered him, he drank eagerly and became much exhilarated, but at the same time much confused. After this he always refused claret, putting the bottle away with a gesture of disapproval. Of water colored by fruit juices he was very fond.

Being left alone in a student's room, he experimented on the bottles there. He drew the cork from bottles of ink and of bay rum; not relishing the contents of either, he poured both into the wash basin.

When he was offered an empty egg shell, he raised it up and looked into the crack from which the contents had been taken. Then he would use his fingers to pull the shell apart, licking the inside of the shell, but apparently disgusted with the small amount of food it contained.

Being shown his reflection in the mirror, he advanced toward it scowling, but soon detecting the sham, he lost all interest in it. A hand glass was given him, but he paid very little attention to his reflection in it, laying it down and turning to other things.

The life of Bob was not without its tender passages. He was loved in turn by the vivacious Mimi and the gentle Nanette. The two stood in much the same relation as the

> ". . . ladies twain
> Who loved so well the tough old dean."

In Borneo, among the tribes of *Cercopithecus*, the male is easily the lord of creation. The female expects to be crowded aside and frequently punished, and takes rude treatment as a matter of course. A kind expression now and then, an occasional hour devoted to hunting *Hæmatopinæ* in her hair, or even a cessation of blows and bites, and she is thankful and satisfied.

Mimi was of the tribe of *Macacus*, gentle in manner, excessively quick of foot, impatient of restraint or even touch from any hand except that of her chosen lord and master. She had large, projecting gray eyes—"pop-eyes" her rivals might have called them—and a wrinkled face suggestive of an age she did not possess. Her face readily assumed an expression of most impatient contempt if any one not of her race attempted to caress her or to take any liberty with her. Mimi had been brought as a child from the south sea islands, and had grown up in a Mayfield beer hall, where she had learned to drink beer with the rest of them, and in general "knew the world," as most of us who live outside the jungles of Borneo are compelled to know it.

Mimi pleased Bob from the first, though he was careful never to let her forget her proper station. If, for example, she had any food he wanted, or if others showed her special attention, he would seize her chain, draw her up to him, and bite her forcibly in the neck, which is the time-honored sign of domestic supremacy in Borneo. At this she would squeal lustily, but she never offered resistance or showed any kind of resentment. Masculine supremacy is acknowledged in the tribe of *Macacus* as in that of *Cercopithecus*. Often Bob would draw Mimi to him to bite her in the neck, apparently to remind her of his superiority. At night they slept together in one box, each with a soft arm round the other's waist.

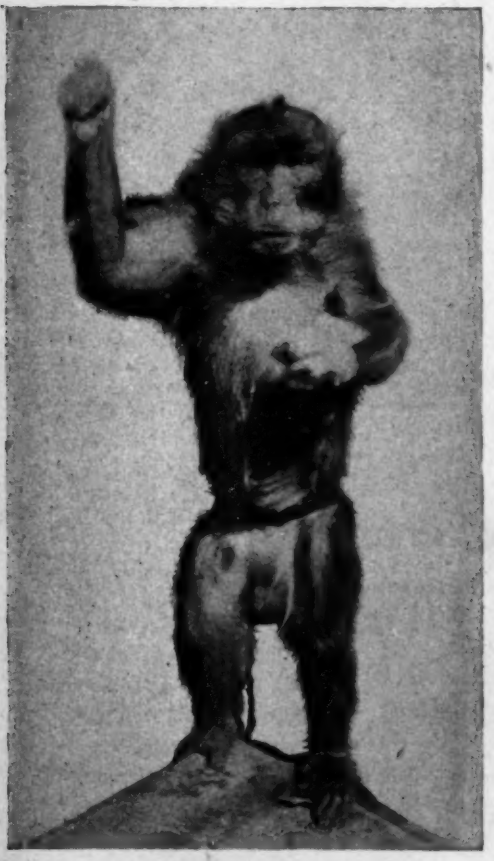
"Chummy."

Nanette, who came later, was also of the tribe of *Macacus*, but she was of a different branch of the great family. She was much larger than Mimi, nearly as large as Bob himself. She had lived in a French family, where she had acquired her name and her calm, considerate manner. She was a gentle blonde, with a pensive, averted face, as though the present was merely an object of toleration with her. Evidently Nanette had had a history, but what that history was no one now can tell. Perhaps there was no history, and her sadly patient expression came from the absence of one.

Mimi was soon very jealous of Nanette, but without good reason, for Bob treated Nanette with uniform contempt, pushing her about and biting her in the neck whenever she came near him. In this Mimi would assist, often seizing Nanette's chain and pulling her about till she was brought within Bob's reach. After a time Mimi's former master returned; she went back to her

drinking of beer, grimacing at visitors, and Bob and this history see her no more.

Meanwhile Nanette and Bob were left together. He remained contemptuous toward her, robbing her of her food and treating her with indignity. Often, when others were looking, Bob would show his authority over her by ostentatiously drawing up her chain and nipping her in the neck; but at other times, when no one was watching, he would relax his dignity and the two would lie for hours in the sunshine, each picking fleas from the other's hair. However, roughly as she was treated, Nanette never showed resentment, and seemed only too glad to be the slave of her royal Bob.



ASPIRATIONS.

At one time Bob had treated Nanette with peculiar severity, for which reason Lady Jane gave him a good beating. Nanette, the gentle, took his part, turned on the lady, and would have severely bitten her had she not been taken off. For two months after, whenever the Lady Jane approached Nanette, she would fly into a passion, scolding, trying to bite, and showing every sign of hate possible to the race of *Macacus*. But Bob had only contempt for feminine wrath and its manifestations. Whenever Nanette made any demonstration against the lady, Bob would seize her and bite her in the neck until she cried for pain. But all this time she would not look at him, but kept her wrathful eyes fixed on the lady, willing to suffer anything rather than have Bob's feelings hurt.

Nanette would often leap into the lap of her keeper, seeking the caresses she did not always secure from Bob. This she would do with the manners of a lapdog or a pampered cat. But Bob

never sought caresses. He was always serious, never in the least playful or sentimental. Any new proposition he always takes seriously. He expects the worst, and scowls and shows his teeth until the matter is thoroughly understood, when he usually becomes indifferent.

One day the children vexed him overmuch, and breaking his chain he came out among them. They fled in consternation, all but the younger one, who was a brave little knight and who stood his ground, though at the cost of a serious biting.

And thus it came that after two years of freedom Bob has returned to the curiosity shop in Kearny Street—not the one on the right as you go up Pine Street, but the other one, where the red-tailed parrots scold and swear, and among whose oaths you may hear all the varied languages of the south sea islands. And there in a little iron cage he remains cramped and unhappy. All day long he rolls back his sneering lips, shakes the cage by pulling against the bars, and swings himself to and fro, trying to overturn the cage and cast it on the floor. And here he waits till his ransom is paid again. Fifteen dollars, I believe, is the sum at which it is fixed. Whoever does this will open for him the door to another series of adventures.

HOW OLD IS THE EARTH?

By Prof. WARREN UPHAM.

WITHIN the memory of men now living, and especially during the last thirty years, the processes of the creation of the earth and its inhabitants, of the solar system, and of the starry heavens, have come to be understood in a very different way from that in which they were thought of by our fathers and forefathers. Instead of the former belief that divine fiats at successive times suddenly spoke into existence the forms of animal and plant life now occupying the earth, the earlier faunas and floras found fossil in the rocks, and at still earlier dates the earth itself, the sun, and the entire astronomic universe, it is now recognized and confidently accepted on all sides that all animals and plants, the globe which we inhabit, and the sun and stars, have been created through slow processes of development, which are well denominated evolution—that is, an unrolling or unfolding. These changes have been in progress during unnumbered and inconceivably long ages; they are still going forward; and they will probably continue as far into the unfathomable future as they have come to us through the dimly and in part somewhat clearly discerned past. To us who are borne upon its bosom this current

seems like the lower Amazon, too broad for us to see its banks, coming from the high Andes and the lower plains, and going to its rest in the ocean.

According to the well-approved nebular hypothesis of Kant and Laplace, the material of our earth and moon became separated from the condensing mass of the sun after the outer planets had been similarly produced, but before the birth of Venus and Mercury. At early stages in the condensation of the revolving nebula, it had thrown off successively the portions of matter which were afterward gathered, by their independent condensation and revolution, to form Neptune, Uranus, Saturn, Jupiter, and Mars; while another portion, which was probably never united like the other planets, made the many small asteroids. The matter which has been changed into our splendidly luminous sun was at one time very attenuated and occupied the whole space inclosed by the orbit of the outermost planet, which was developed from a comparatively very small cloud or ring of this matter, centrifugally detached from the revolving exceedingly tenuous mass. In like manner the material of each of the planets, including the earth, was shed from the whirling nebula at times during its decrease in volume when its circumference was approximately coincident with their orbits.

Again, in their turn the planetary masses have undergone the same evolutionary process, taking a rotary motion and throwing off, as they condensed, the material which now circles about them in the shape of moons and rings. In the case of our own planet and its single large satellite, probably the far greater part of the original cloud or ring whence they were produced had assumed a somewhat globular or discoid form and taken a movement of revolution which still continues as the earth's daily rotation, before the moon's mass was separated from that of the earth. It seems to me, however, very improbable that the present contour of our globe should preserve, as suggested by Fisher, the scars of this loss in the depressions of the deep ocean basins.

Many relatively small portions of the ring of matter producing the earth and moon may have become early separated from the chief condensing mass, and after its division in our globe and its satellite have been drawn by gravitation into them, marring the face of the moon, as Gilbert supposes, with its multitudes of both small and very large crateriform scars. On the earth, too, if this hypothesis be true, such falling asteroid-like bodies must also have made similar small and huge blots by their violent impact; but they evidently were effaced by the slow processes of atmospheric and stream erosion, or in basin areas were deeply covered by sediments, before the formation of the oldest of our

fossiliferous strata. The absence of either air or water on the moon has allowed the steep and jagged mountain rims of the deeply depressed lunar craters to remain nearly unchanged from the almost inconceivably remote time, according to this view, when the asteroid bombardment of the moon was completed.

Geology, or the science of the earth's changes and development, deals with the rocks forming the crust of our globe. From their stratigraphic sequence and the successive fossil faunas and floras found in them, the geologist gathers the history of the sedimentation or volcanic eruption of the rocks and the concurrent changes of animal and plant life. Moreover, by reasoning from the physical condition and structure of the rock formations, from volcanic action, earthquakes, and the upheaval of continents and mountain ranges, he conjectures what may be the condition of the deep interior of the earth, through its observed influence upon the crust. Both these phases of the science have yielded estimates of the age of the earth, the former based on the geologic processes of erosion and deposition, the latter on the earth's loss of internal heat, the magnitude and the effects of the oceanic tides, and other conditions whose investigation belongs more specially to the physicist and astronomer. Each takes up the question for the later part of the earth's planetary existence, after it was so far condensed and cooled that it had already attained approximately its present size and was enveloped by a crust which, through many stages of diverse changes, has continued to the present day.

The estimates derived from these two directions of inquiry, however, differ considerably among themselves, and especially it is noticeable that in general the physical and astronomical investigations of the question yield smaller estimates than those drawn from stratigraphic and paleontologic data. Sir William Thomson (now Lord Kelvin) long ago estimated, from his study of the earth's internal heat, its increase from the surface downward, and the rate of its loss by radiation into space, that the time since the consolidation of the surface of the globe has been somewhere between twenty million and four hundred million years, and that most probably this time and all the geologic record must be limited within one hundred million years. Mr. Clarence King, from very careful experiments on the volcanic rock diabase, supposed to represent the average constitution of the earth's crust, when subjected to extremes of heat and pressure, applying his results in the same way as Lord Kelvin, has within the present year published his conclusion that the earth's duration measures only about twenty-four million years. Prof. George H. Darwin computes, from the influence of tidal friction in retarding the earth's rotation, that probably only fifty-seven million years have elapsed since the moon's mass was shed from the revolving molten

earth, long before the formation of its crust. From the same arguments and the rate at which the sun is losing its store of heat, Prof. Guthrie Tait affirms that apparently ten million years are as much as physical science can allow to the geologist. Prof. Newcomb writes: "If the sun had, in the beginning, filled all space, the amount of heat generated by his contraction to his present volume would have been sufficient to last eighteen million years at his present rate of radiation. . . . Ten million years . . . is, therefore, near the extreme limit of time that we can suppose water to have existed on the earth in the fluid state." Not only the earth but even the whole solar system, according to Newcomb, "must have had a beginning within a certain number of years which we can not yet calculate with certainty, but which can not much exceed twenty million, and it must end."

The geologist demurs against these latter far too meager allotments of time for the wonderful, diversified, and surely vastly long history which he has patiently made out in his perusal of the volume of science disclosed by the rocks. He can apparently do very well with Lord Kelvin's original estimate, but must respectfully dissent from the less liberal opinions noted. Somewhere in the assumed premises which yield to mathematicians these narrow limits of time, there must be conditions which do not accord with the actual constitution of the sun and earth. It must be gratefully acknowledged, however, in the camp of the geologists, that we owe to these researches a beneficial check against the notion once prevalent that geologic time extends back practically without limit; and it is most becoming for us carefully to inquire how closely the apparently conflicting testimonies of geology and physics may be brought into harmony by revision of each.

Among all the means afforded by geology for direct estimates of the earth's duration, doubtless the most reliable is through comparing the present measured rate of denudation of continental areas with the aggregate of the greatest determined thickness of the strata referable to the successive time divisions. The factors of this method of estimate, however, are in considerable part uncertain, or dependent on the varying opinions of different geologists. According to Sir Archibald Geikie, in his presidential address a year ago before the British Association, the time thus required for the formation of all the stratified rocks of the earth's crust may range from a minimum of seventy-three million up to a maximum of six hundred and eighty million years. Prof. Samuel Haughton obtains in this way, "for the whole duration of geological time a minimum of two hundred million years." On the other hand, smaller results are reached through the same method by Dana, who conjectures that the earth's age may be

about forty-eight million years since the formation of the oldest fossiliferous rocks; and by Alfred Russel Wallace, who concludes that this time has probably been only about twenty-eight million years. With these, rather than with the foregoing, we may also place Mr. T. Mellard Reade's recent estimate of ninety-five million years, similarly derived. Again, Mr. C. D. Walcott, in his vice-presidential address before Section E of the American Association for the Advancement of Science, in its meeting last August, gave his opinion, from a study of the sedimentary rocks of the western Cordilleran area of the United States, that the duration of time since the Archæan era has been probably some forty-five million years.

Selecting the lowest of these various estimates as the nearest in accord with the conclusions of physical and astronomical science, let us scrutinize the processes of Wallace's measurements and computations. It has been found that the rates at which rivers are lowering the altitudes of their basins by the transportation of sediments to the sea vary from an average of one foot taken from the land surface of its hydrographic basin by the river Po in seven hundred and thirty years, to one foot by the Danube in six thousand eight hundred years. As a mean for all the rivers of the world, Wallace assumes that the erosion from all the land surface is one foot in three thousand years. The sediments are laid down in the sea on an average within thirty miles from the coast, and all the coast lines of the earth have a total measured length, according to Dr. James Croll and Mr. Wallace, of about one hundred thousand miles, so that the deposition is almost wholly confined to an area of about three million square miles. This area is one nineteenth as large as the earth's total land area; hence it will receive sediment nineteen times as fast as the land is denuded, or at the rate of about nineteen feet of stratified beds in three thousand years, which would give one foot in one hundred and fifty-eight years. With this Wallace compares the total maxima of all the sedimentary rocks of the series of geologic epochs, measured in whatever part of the earth they are found to have their greatest development. Prof. Haughton estimates their aggregate to be one hundred and seventy-seven thousand two hundred feet, which, multiplied by one hundred and fifty-eight, gives approximately twenty-eight million years as the time required for the deposition of the rock strata in the various districts where they are thickest and have most fully escaped erosion and redeposition.

Most readers, following this argument, would infer that it must give too large rather than too scanty an estimate of geologic duration; but to many students of the earth's stratigraphy it seems more probably deficient than excessive. All must confess

that the argument rests upon many indeterminate premises, since the total extent of the land areas and the depths of the oceans have probably been increasing through the geologic eras, and the effects of tides have probably diminished. The imperfection of the geologic record, so impressively shown by Charles Darwin in respect to the sequence of plants and animals found fossil in the rocks, will also be appealed to as opposing the assumption that the one hundred and seventy-seven thousand two hundred feet, or thirty-three and a half miles, of strata represent the whole, or indeed any more than a small fraction, of the earth's history. To myself, however, this last objection seems unfounded, since in many extensive and clearly conformable sections observed on a grand scale in crossing broad areas, there is seen to have been evidently continuous deposition during several or many successive geologic epochs; and by combining such sections from different regions a record of sedimentation is made well-nigh complete from the earliest Palæozoic morning of life to its present high noon. But perhaps we may do better to change somewhat the premises of our computation, in view of the extensive regions where the rock strata remain yet to be thoroughly explored, and because of certain large inland tracts having little rain and therefore no drainage into the sea. If we assume that the total maxima of strata amount to fifty miles, and that the mean rate of the land denudation is only one foot in six thousand years, we then obtain a result three times greater than before, or about eighty-four million years for the deposition of the stratified rocks.

Another method of considering this problem is afforded by the determination of one term in a sequence of ratios, whereby the sum of the whole becomes known. Though geologists differ widely in their estimates of the earth's age, up to the seven thousand million years claimed by McGee, in an address last year before the American Association, they are approximately in agreement as to the ratios of the several great divisions of geologic time. From the thicknesses of the strata and the changes in the animal and plant life, it is comparatively easy to determine the relative lengths of the successive eras, while yet it is very difficult to decide beyond doubt even the approximate length in years of any part of the record. The portions for which we have the best means of determining their lengths are the Glacial and recent periods, the latter extending from the Champlain epoch, or closing stage of the ice age to the present time, while these two divisions, the Glacial or Pleistocene period and the recent, make up the Quaternary era. If we can only ascertain somewhat nearly what has been the duration of this era, from the oncoming of the Ice age until now, it will serve as a known quantity to be used as the multiplier for giving us the approximate or probable meas-

ures in years for the recedingly earlier and far longer Tertiary, Mesozoic or Secondary, Palæozoic or Primary, and Archæan or Beginning eras, which last takes us back almost or quite to the time when the cooling molten earth became first enveloped with a solid crust.

Haughton has estimated time ratios from two series of data. His results deduced from the maximum thickness of the strata for the three grand divisions of Archæan, Palæozoic, and subsequent time, expressed in percentages, are 34·3 : 42·5 : 23·2; and from his computations as to the secular cooling of the earth, 33·0 : 41·0 : 26·0. The ratios reached by Profs. J. D. Dana and Alexander Winchell from the thicknesses of the rock strata are closely harmonious, the durations of Palæozoic, Mesozoic, and Cenozoic time being to each other as 12 : 3 : 1. The Tertiary and Quaternary ages, the latter extending to the present day, which are here united as the Cenozoic era, Dana would rank approximately in the ratio of 3 : 1, giving to the Quaternary a sixty-fourth part of all time since the beginning of the Cambrian period, to which our earliest well-preserved fossil faunas belong. For reasons to be stated later, I think that this estimate of the relative length of Quaternary time is greatly exaggerated; but this would not sensibly affect the general ratios.

Prof. W. M. Davis, of Harvard University, without speaking definitely of the lapse of time by years, has endeavored to give some conception of what these and like estimates of geologic ratios really mean, through a translation of them into terms of a linear scale. Starting with the representation of the postglacial or recent period, since the North American ice-sheet was melted away, as two inches, he estimates that the beginning of the Tertiary erosion of the Hudson River gorge through the Highlands would be expressed by a distance of ten feet; that the Triassic reptilian tracks in the sandstone of the Connecticut Valley would be probably fifty feet distant; that the formation of the coal beds of Pennsylvania would be eighty or one hundred feet back from the present time; and that the Middle Cambrian trilobites of Braintree, Mass., would be two hundred, three hundred, or four hundred feet from us.

Having such somewhat definite and agreeing ratios, derived from various data by different investigators, can we secure the factor by which they should be multiplied to yield the approximate duration of geologic epochs, periods, and eras, in years? If on the scale used by Prof. Davis we could substitute a certain time for the period since the departure of the ice-sheet, we should thereby at once determine, albeit with some vagueness and acknowledged latitude for probable error, how much time has passed since the Triassic tracks were made, the coal deposited, and the

trilobites entombed in the Cambrian slates. Now, just this latest and present division of the geologic record, following the Ice age, is the only one for which geologists find sufficient data to permit direct measurements or estimates of its duration. "The glacial invasion from which New England and other northern countries have lately escaped," remarks Davis, "was prehistoric, and yet it should not be regarded as ancient."

In various localities we are able to measure the present rate of erosion of gorges below waterfalls, and the length of the postglacial gorge divided by the rate of recession of the falls gives approximately the time since the Ice age. Such measurements of the gorge and Falls of St. Anthony by Prof. N. H. Winchell show the length of the postglacial or recent period to have been about eight thousand years; and from the surveys of Niagara Falls Mr. G. K. Gilbert believes it to have been seven thousand years, more or less. From the rates of wave-cutting along the sides of Lake Michigan and the consequent accumulation of sand around the south end of the lake, Dr. E. Andrews estimates that the land there became uncovered from its ice-sheet not more than seventy-five hundred years ago. Prof. G. Frederick Wright obtains a similar result from the rate of filling of kettle-holes among the gravel knolls and ridges called kames and eskers, and likewise from the erosion of valleys by streams tributary to Lake Erie; and Prof. Benjamin K. Emerson, from the rate of deposition of modified drift in the Connecticut Valley at Northampton, Mass., thinks that the time since the Glacial period can not exceed ten thousand years. An equally small estimate is also indicated by the studies of Gilbert and Russell for the time since the last great rise of the Quaternary lakes Bonneville and Lahontan, lying in Utah and Nevada, within the arid Great Basin of interior drainage, which are believed to have been contemporaneous with the great extension of ice-sheets upon the northern part of our continent.

Prof. James Geikie maintains that the use of palæolithic implements had ceased, and that early man in Europe made neolithic (polished) implements, before the recession of the ice-sheet from Scotland, Denmark, and the Scandinavian peninsula; and Prestwich suggests that the dawn of civilization in Egypt, China, and India may have been coeval with the glaciation of northwestern Europe. In Wales and Yorkshire the amount of denudation of limestone rocks on which bowlders lie has been regarded by Mr. D. Mackintosh as proof that a period of not more than six thousand years has elapsed since the bowlders were left in their positions. The vertical extent of this denudation, averaging about six inches, is nearly the same with that observed in the southwest part of the province of Quebec by Sir William Logan and Dr.

Robert Bell, where veins of quartz marked with glacial striæ stand out to various heights not exceeding one foot above the weathered surface of the inclosing limestone.

From this wide range of concurrent but independent testimonies we may accept it as practically demonstrated that the ice-sheets disappeared from North America and Europe some six to ten thousand years ago. But having thus found the value of one term in our ratios of geologic time divisions, we may know them all approximately by its substitution. The two inches assumed to represent the postglacial portion of the Quaternary era may be called eight thousand years; then, according to the proportional estimates by Davis, the Triassic period was probably two million four hundred thousand years ago; the time since the Carboniferous period, in the closing part of the Palæozoic era, has been about four or five million years; and since the middle of the Cambrian period, twice or perhaps four times as long. Continuing this series still further back, the earliest Cambrian fossils may be twenty or twenty-five million years old, and the beginning of life on our earth was not improbably twice as long ago.

Seeking to substitute our measure of postglacial time in Dana's ratios, we are met by the difficulty of ascertaining first its proportion to the preceding Glacial period, and then the ratio which these two together bear to the Tertiary era. It would fill a very large volume to rehearse all the diverse opinions current among glacialists concerning the history of the Ice age, its wonderful climatic vicissitudes, and the upward and downward movements of the lands which are covered with the glacial drift. Many eminent glacialists, as James Geikie, Wahnschaffe, Penck, De Geer, Chamberlin, Salisbury, Shaler, McGee, and others, believe that the Ice age was complex, having two, three, or more epochs of glaciation, divided by long interglacial epochs of mild and temperate climate when the ice-sheets were entirely or mainly melted away. Prof. Geikie claims five distinct glacial epochs, as indicated by fossiliferous beds lying between deposits of till or unstratified glacial drift, and by other evidences of great climatic changes. In this country Mr. McGee recognizes at least three glacial epochs. The astronomic theory of Croll attributes the accumulation of ice-sheets to recurrent cycles which bring the winters of each polar hemisphere of the earth alternately into aphelion and perihelion each twenty-one thousand years during the periods of maximum eccentricity of the earth's orbit. Its last period of this kind was from about two hundred and forty thousand to eighty thousand years ago, allowing room for seven or eight such cycles and alternations of glacial and interglacial conditions. The supposed evidence of interglacial epochs therefore gave to this theory a wide credence; but the recent determina-

tions of the geologic brevity of the time since the ice-sheets disappeared from North America and Europe make it clear, in the opinions even of some of the geologists who believe in a duality or plurality of Quaternary Glacial epochs, that not astronomic but geographic causes produced the Ice age.

Glacialists who reject Croll's ingenious and brilliant theory mostly appeal to great preglacial altitude of the land as the chief cause of the ice accumulation, citing as proof of such altitude the fiords and submarine valleys which on the shores of Scandinavia, and the Atlantic, Arctic, and Pacific coasts of North America, descend from one thousand to three thousand and even four thousand feet below the sea level, testifying of former uplifts of these continental areas so much above their present heights. But beneath the enormous weights of their ice-sheets these lands sank, so that when the ice attained its maximum area and thickness and during its departure the areas on which it lay were depressed somewhat lower than now and have since been re-elevated. This view to account for the observed records of the Glacial period is held by Dana, Le Conte, Wright, Jamieson, and others, including the present writer. It is believed to be consistent either with the doctrine of two or more glacial epochs during the Quaternary era, or with the reference of all the glacial drift to a single glacial epoch, which is thought by Wright, Prestwich, Lamplugh, Falsan, Holst, Nikitin, and others to be more probable. To myself, though formerly accepting two glacial epochs with a long warm interval between them, the essential continuity of the Ice age seems now the better provisional hypothesis, to be held with candor for weighing evidence on either side.

The duration of the Ice age, if there was only one epoch of glaciation, with moderate temporary retreats and readvances of the ice border sufficient to allow stratified beds with the remains of animals and plants to be intercalated between accumulations of till, may only have comprised a few tens of thousands of years. On this point Prof. Prestwich has well written as follows: "For the reasons before given, I think it possible that the Glacial epoch —that is to say, the epoch of extreme cold—may not have lasted longer than from fifteen thousand to twenty-five thousand years, and I would for the same reasons limit the time of . . . the melting away of the ice-sheet to from eight thousand to ten thousand years or less."

From these and foregoing estimates, which seem to me acceptable, we have the probable length of Glacial and postglacial time together thirty thousand or forty thousand years, more or less; but an equal or considerably longer preceding time, while the areas that became covered by ice were being uplifted to great altitudes, may perhaps with good reason be also included in the Quaternary

era, which then would comprise some one hundred thousand years. Comparing the Tertiary era with the Quaternary, however, I can not agree with Prof. Dana's estimate that the latter was a third as long as the former, and am quite at a loss to discern evidences justifying that view. The best means for learning their ratio I think to be found in the changes of faunas and floras since the beginning of the Tertiary era, using especially the marine molluscan faunas as most valuable for this comparison. Scarcely any species of marine mollusks have become extinct or undergone important changes during the Glacial and recent periods; but since the Eocene dawn of the Tertiary nearly all of these species have come into existence. Judged upon this basis, the Tertiary era seems probably fifty or a hundred times longer than the Ice age and subsequent time; in other words, it may well have lasted two million or even four million years. Taking the mean of these numbers, or three million years, for Cenozoic time, or the Quaternary and Tertiary ages together, we have precisely the value of Prof. Dana's ratios which he himself assumes for conjectural illustration, namely, forty-eight million years since the Cambrian period began. But the diversified types of animal life in the earliest Cambrian faunas surely imply a long antecedent time for their development, on the assumption that the Creator worked before then as during the subsequent ages in the evolution of all living creatures. According to these ratios, therefore, the time needed for the deposition of the earth's stratified rocks and the unfolding of its plant and animal life must be about a hundred million years.

Reviewing the several results independently reached through the geologic estimates and ratios supplied by Wallace, Dana, and Davis, we are much impressed and convinced of their approximate truth by their somewhat good agreement among themselves, which seems as close as the nature of the problem would lead us to expect, and by their all coming within the limit of one hundred million years which Sir William Thomson estimated on physical grounds. This limit of probable geologic duration seems therefore fully worthy to take the place of the once almost unlimited assumptions of geologists and writers on the evolution of life, that the time at their disposal has been practically infinite. No other more important conclusion in the natural sciences, directly and indirectly modifying our conceptions in a thousand ways, has been reached during this century.

MODERN WAR VESSELS OF THE UNITED STATES NAVY.

By W. A. DOBSON, M. S. N. A.

Illustrated by CHARLES C. DODGE.

AT the close of the civil war the United States possessed a navy consisting in the main of monitors, double and single turreted, and a large fleet of wooden vessels of various types and classes; they were armed principally with smooth-bore guns and Parrott rifles, all of which were muzzle-loading; but the four years of strife which developed the monitor, the fifteen-inch gun with its mammoth powder, and the destructive capabilities of the torpedo were destined to overthrow Old World ideas of battle-ship requirements, to turn the thoughts of naval men abroad in entirely new and novel directions, and to inaugurate a new system of design and construction. Among the forms of naval architecture developed by the exigencies of the war the most notable is the monitor type, and therein contained was the germ from which was to spring a new development of war vessels, for, although the nation was so worn with the long struggle that it was glad to turn the energies that had been devoted to the enterprises of war to the pursuits of peace, and found itself too heavily burdened with debt to embody its naval experience in a new navy, the lessons given in naval construction and warfare were eagerly seized upon by European naval architects, and from the monitor of Ericsson, combined with Timby's revolving fort and its successors, was evolved the battle-ship of to-day. The United States having thus laid down the broad lines along which was to be developed the present fighting machine, with its steel built-up rifled guns, the slow-burning smokeless powder, the automobile and dirigible torpedoes, contented itself for the next decade and a half with building a few vessels of iron, building and repairing its wooden vessels, and converting the smooth-bore guns into makeshift rifles. Abroad, the navies of France and England adopted the monitor idea of protection to hull and machinery by means of vertical side armor, extending from a few feet below to a few feet above the load line, surmounted by a flat armored deck, with the guns placed in revolving forts or turrets, protected by walls of heavy armor; and in order to increase the habitability and sea-going qualities, light upper or false works were erected upon the armor deck, in which were placed the quarters and secondary armament. In order to obtain a hull structure sufficiently light and strong to allow a considerable amount of displacement to be devoted

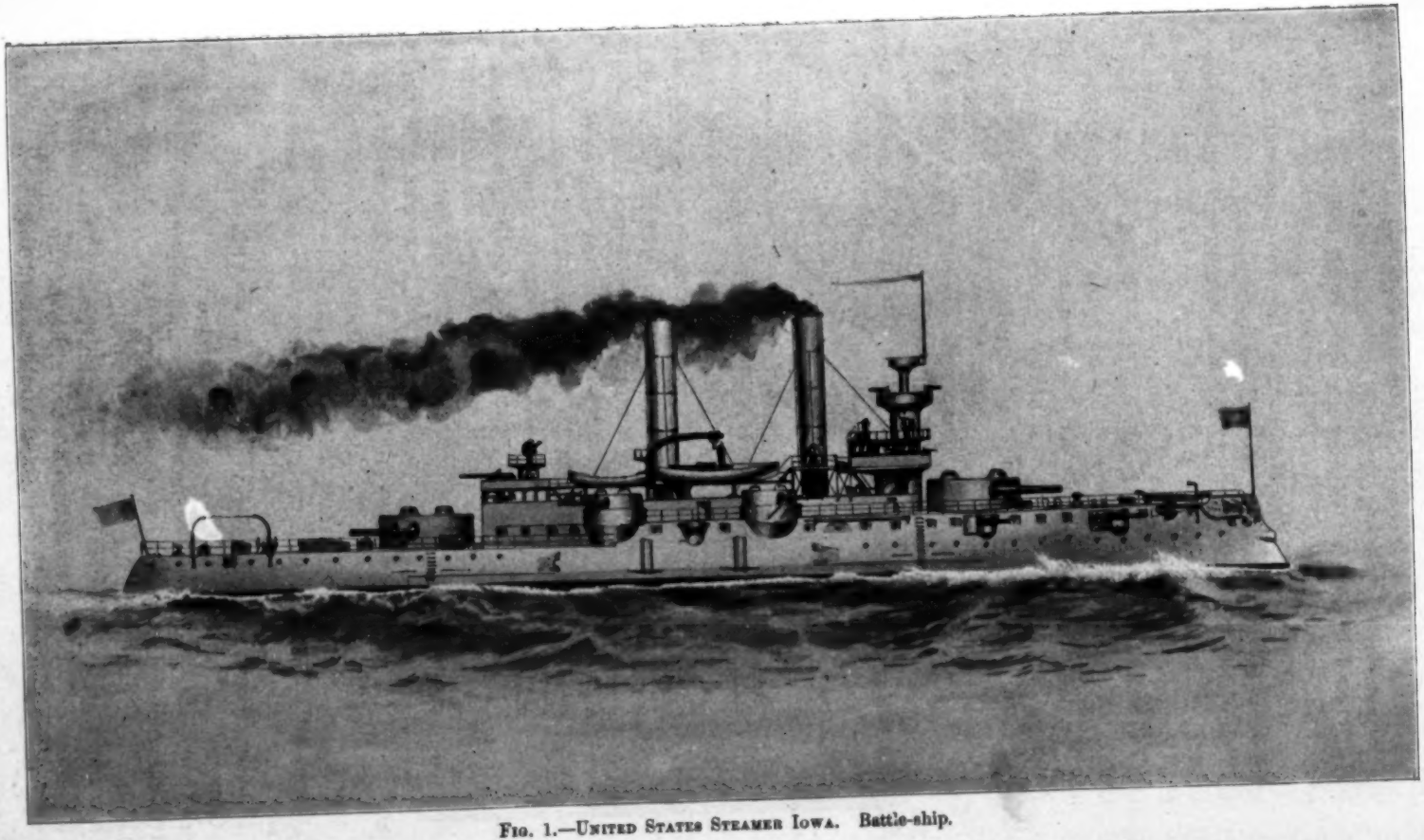


FIG. 1.—UNITED STATES STEAMER IOWA. Battle-ship.

to purposes of protection, a style of construction now universally adopted and known as cellular was developed by Sir E. J. Reed, then chief constructor of the British Navy, in which the maximum of strength with the minimum of weight was sought after and very fairly obtained. Then began, what has continued to this day, the race between armor and armament; the makers of armor striving to make plates that would effectually resist the largest guns, and the gun-makers using every means at their command to produce guns capable of breaking up or penetrating the heaviest armor. The outcome is, on the side of armor, the solid steel plate with a face case-hardened by the Harvey process—a face so hard that no drill will in the slightest degree affect it, and this extreme hardness gradually shaded off to a soft back to prevent through cracks. On the other hand is the steel built-up breech-loading gun, with a length of from thirty-five to forty-five times its diameter of bore, using slow-burning powder, having low initial pressures and giving a muzzle velocity from two thousand to twenty-five hundred feet per second, and special steel armor-piercing projectiles for the purpose of racking or breaking up the armor and then piercing the hull. This competition has indirectly opened up a new material of some twenty per centum greater strength when compared with wrought iron, known as mild steel, which naval architects are employing to enable them to produce lighter structures, and to use the weight saved in giving greater thickness to the armor, increased armament, or added power and speed, as the necessities of the design contemplated may demand. Shortly after the introduction of this material, or in 1882, the Congress of the United States appropriated for the construction of three cruisers and one dispatch boat, which are now familiar to us all under the names of the Chicago, Boston, Atlanta, and Dolphin; fortunately for our Government, its corps of naval constructors and engineers had by repeated visits to the ship-yards and gun factories abroad, and a close study of the principles involved in the new methods of construction, kept themselves fully

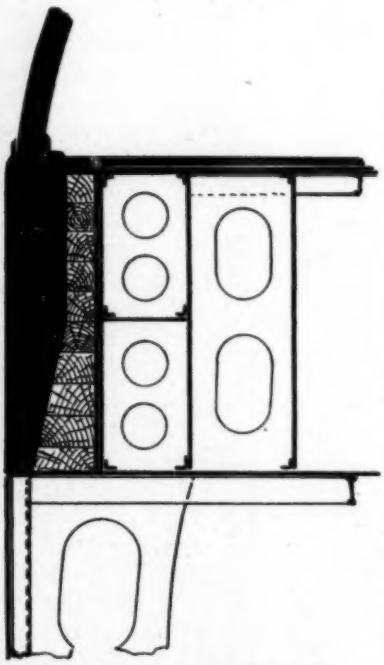


FIG. 2.—IOWA. Section through Armor.

abreast of the progress being made in shipbuilding, marine engineering, and naval artillery, and were thus enabled when the opportunity was given by Congress to promptly take up the work of rehabilitating the navy, and carry it forward successfully. Congress in its appropriation had stipulated that the new vessels were to be constructed of steel; this meant a considerable outlay in capital to the metal producers of the country, who, with the exception of some firms making a specialty of tool steel, had been engaged mainly in the manufacture of wrought iron. However, having full confidence in the determination of Congress to give the country a new navy, they did not hesitate to at once install plants capable of manufacturing steel suitable for shipbuilding and boiler construction, of steel of a higher grade for the construction of high-powered built-up guns, and of producing steel for armor plates weighing from thirty to forty tons each. It is worthy of note that these industries, built up within a decade under the stimulus given by the rebuilding of the navy, to-day challenge the world to produce better material. So rapid has been the progress of our manufacturers, and so fully have all demands upon them been met, that one of our shipbuilding firms is now constructing two mammoth steamers for the Inman International Line, whose ves-

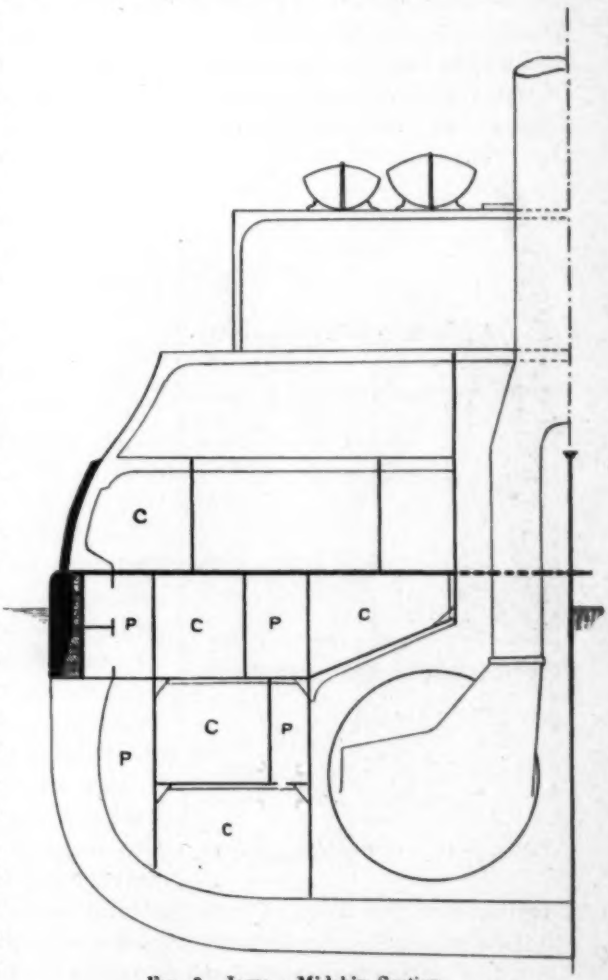


FIG. 3.—IOWA. Midship Section.
C, C, C, coal; P, P, P, passages.

sels have, since its organization, been constructed on the other side of the Atlantic.

The types of war vessels considered by naval authorities to be best suited to the needs of our service may be classed in general terms as battle-ships, armored cruisers, protected cruisers, harbor-defense monitors, gunboats, torpedo-boats (surface and submarine), and rams. The uses and functions of each type differ greatly; some of the more prominent may be broadly stated here.

Taking first the battle-ships, we find them to be, of all the types of war vessels, the most powerful in the feature of offense and defense; they are intended to stand and fight, to give and take blows like giants in a prize ring; and the reason can be plainly seen when we appreciate the fact that an enemy can bring his battle-ship within twelve miles of our large seaboard cities, and there taking up a position of vantage, secure from any attack by land, shell the city; the only vessel, then, that can dispute possession with him point by point is a ship of similar powers of doing battle, however successful an attack by torpedo-boat, either surface or submarine, may be when the conditions are suitable. The points, therefore, to be emphasized in the design are protection and armament, or the power to deliver heavy blows with the ability to withstand those of its antagonist; with these must be combined power to enable it to act on the offensive, such as speed, endurance, habitability, and form of hull that will insure seaworthiness.

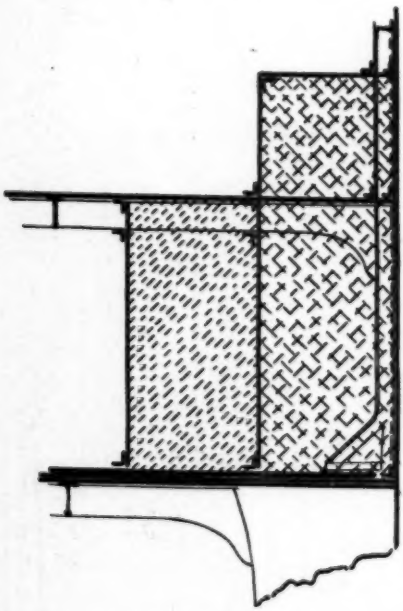


FIG. 4.—IOWA.
Section through Coffer Dams, etc.

As a purely harbor-defense vessel the monitor stands pre-eminent, the entire hull and battery being protected by armor, and at the same time offering such a small target that it is extremely difficult to hit; but its military value is very seriously impaired when in a seaway, by the short distance of the guns above the water, it being impossible to use them in a heavy sea. Perhaps the vessels most useful for all-around work are the armored cruisers, as they are intended to have great speed, great endurance, guns capable of coping with vessels inferior only to battle-ships, with a very considerable amount of protection afforded to the hull and

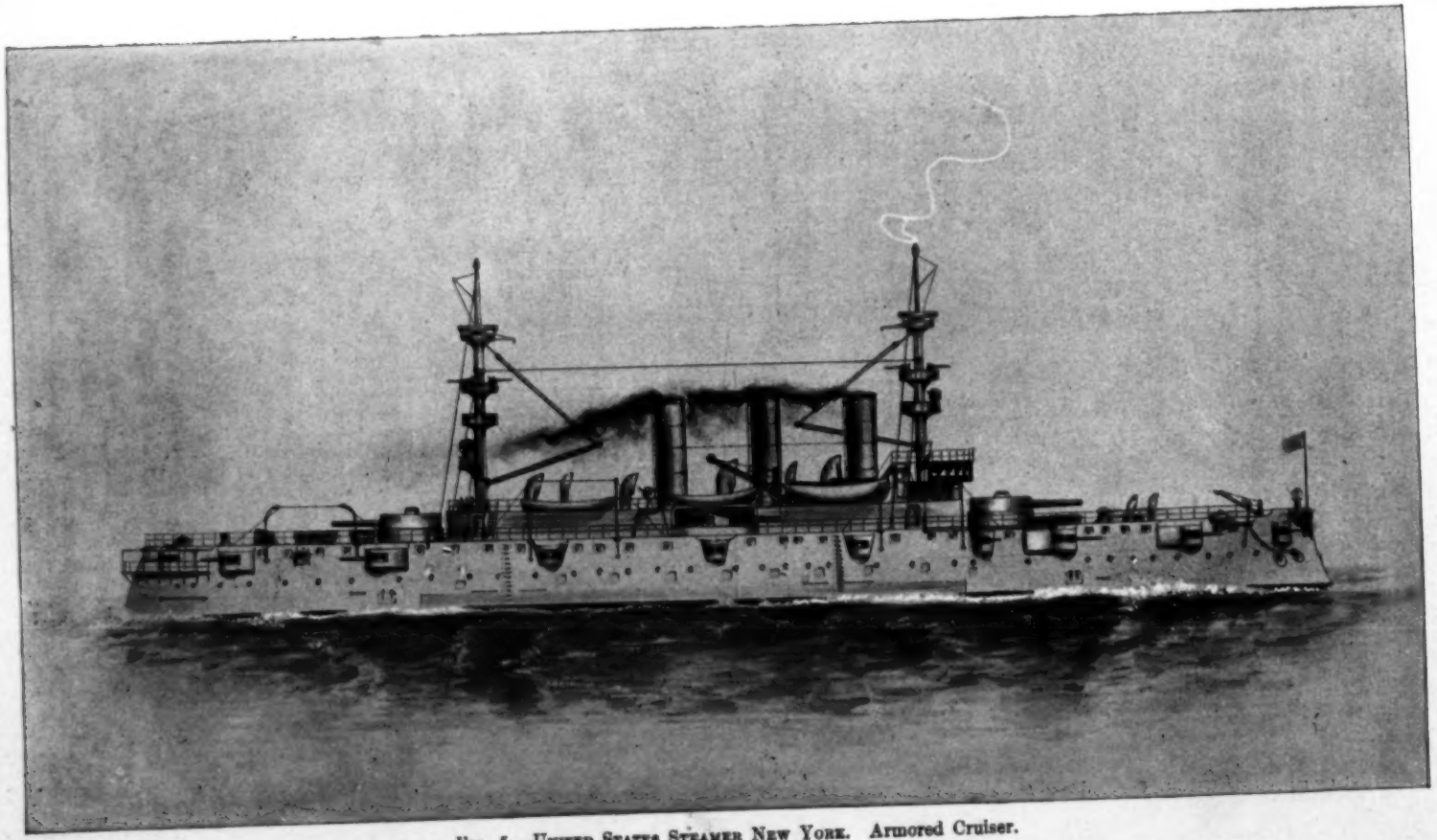


Fig. 5.—United States Steamer New York. Armored Cruiser.

armament; their function in war is to capture the commerce-destroyers of the enemy, to act as commerce-destroyers themselves, and to convoy and protect fleets of large and fast merchant vessels. To accomplish these purposes great speed is necessary, either to overtake or convoy swift merchantmen; great endurance or coal supply, to enable them to keep the sea for long periods on the path usually frequented by merchant vessels; and offensive and defensive power sufficient to enable them to successfully resist the attacks of vessels of their own class.

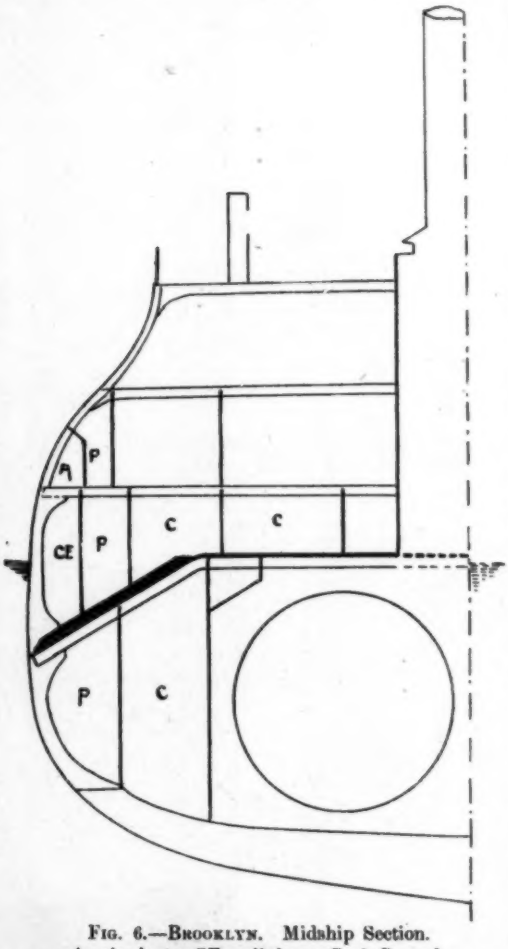


FIG. 6.—BROOKLYN. Midship Section. A, air duct; CE, cellulose; C, C, C, coal; P, P, P, passages.

The type next in importance and general usefulness is styled the protected cruiser, or those whose only protection against injury consists of sloping armor decks of varying thickness, in combination with coffer dams filled with water-excluding material and closely divided compartments in the region of the line of flotation. The characteristics of this type are not capable of being so clearly defined as those already considered, as they include such widely differing vessels as the triple-screw Columbia of 7,350 tons displacement, the Olympia of 5,500 tons, down to cruisers of 2,000 and 3,000 tons displacement as represented by the Cincinnati and Detroit. Their function is a varied though exceedingly useful one; some are designed particularly for preying upon the commerce of an enemy so as to cripple its resources, the most notable examples being the Columbia of our own and the Blake of the British Navy.

Speed and endurance are the features emphasized, combined with guns of light caliber for dealing with unarmed vessels;

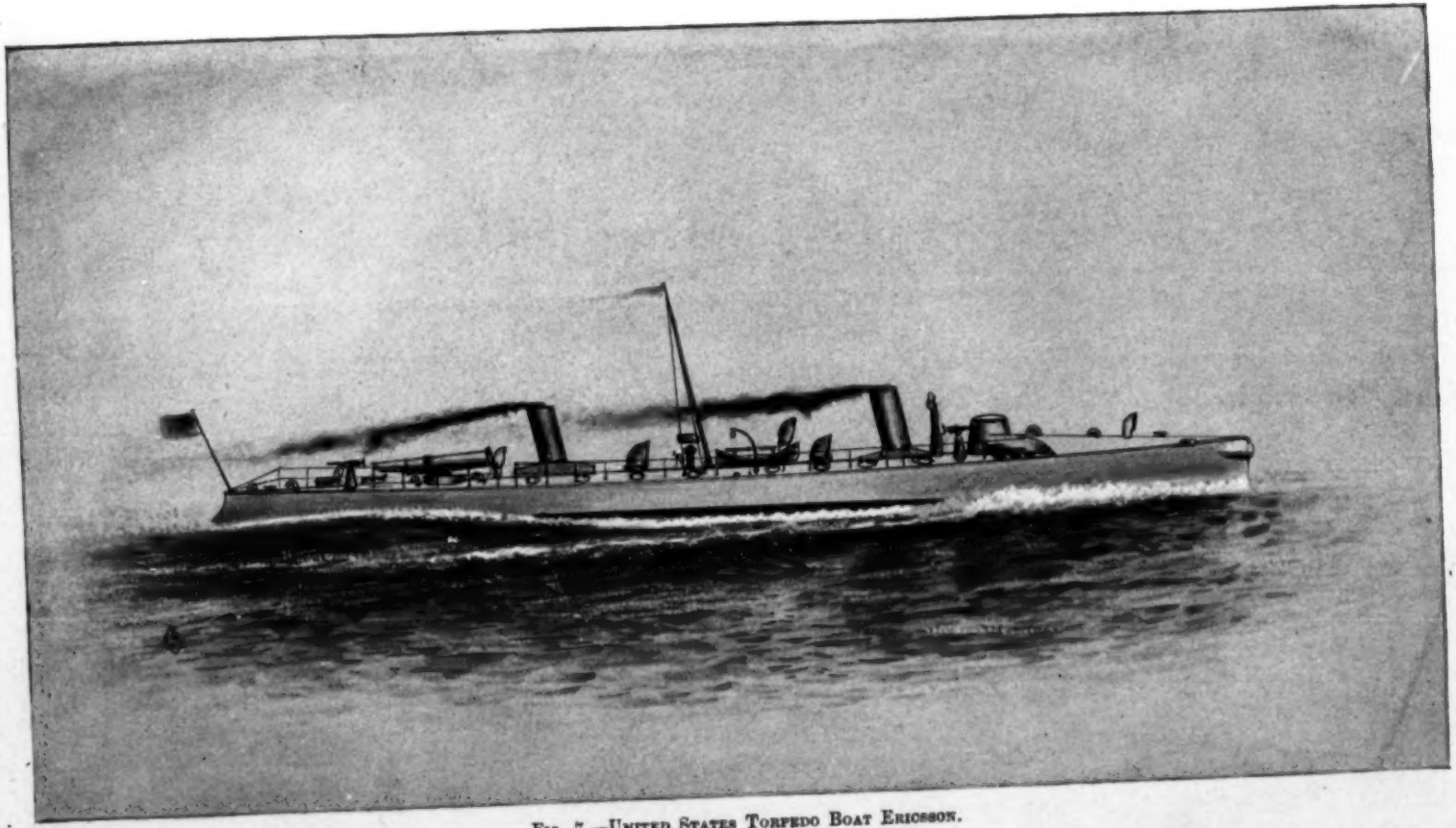


Fig. 7.—United States Torpedo Boat Ericsson.

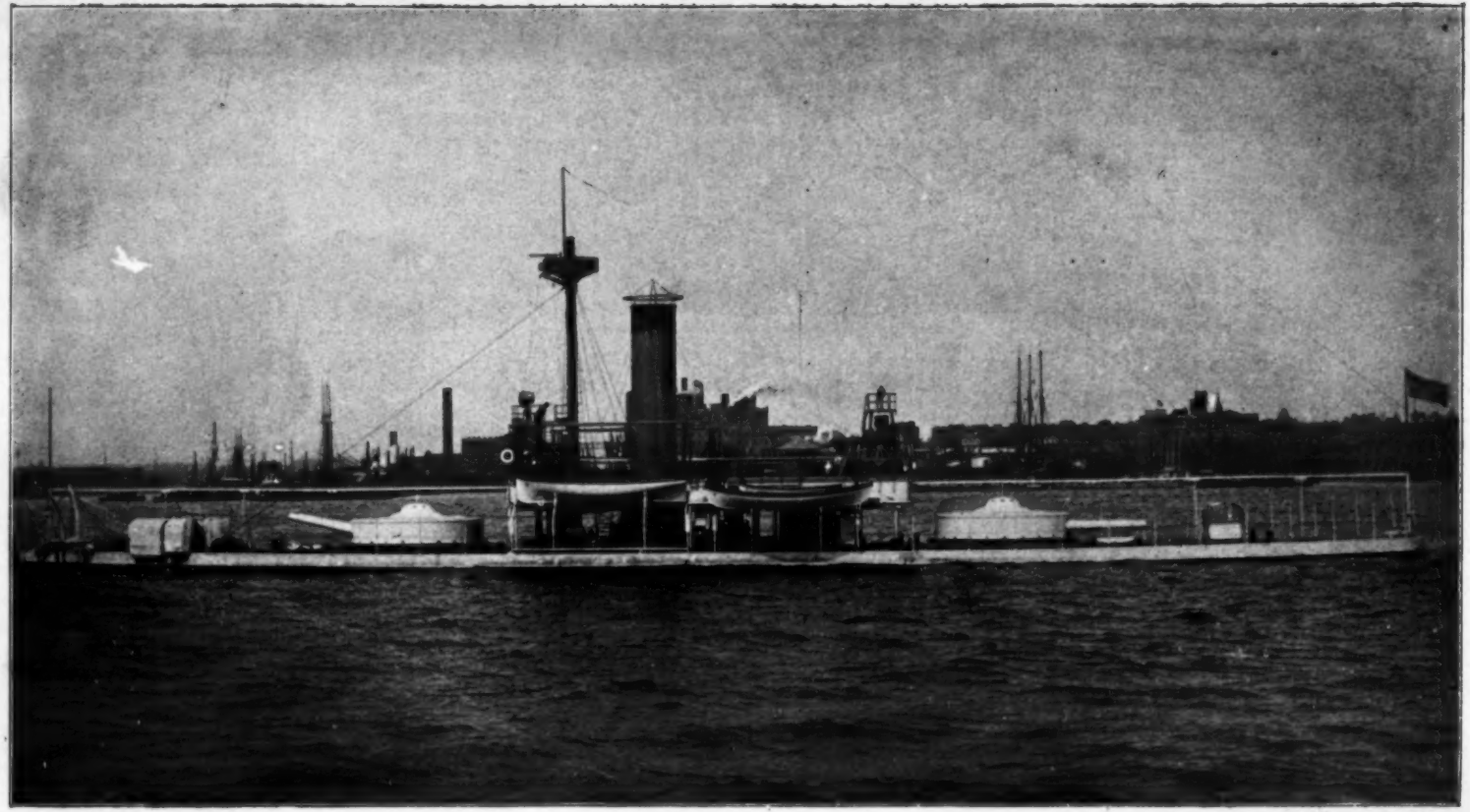


Fig. 8.—United States Steamer Miantonomoh. Monitor.

others again, like the Chicago, Newark, Baltimore, and San Francisco, are designed for purposes of general utility, such as protecting our mercantile interests abroad, the one feature emphasized being endurance, with those of speed, protection, and armament very fairly developed. Our gunboats of the Yorktown and Machias types are miniature cruisers, except that speed has been sacrificed to enable them to carry heavy batteries; at present they are constructed entirely of steel, although many fruitless efforts have been made to adopt in this class the style of construction known as composite—that is, all the parts of steel as is customary, except the outer covering of the hull, which is formed of wood planking coppered instead of steel plating. This system has been most earnestly and ably advocated by Chief Naval Constructor Philip Hichborn, and has formed the subject of special reports by him to the Navy Department, but the wording of the congressional appropriations has been such as to preclude its adoption.

The advantages to be gained are cheapness and ease of maintenance, freedom from fouling and consequent ease of propulsion, with the ability to keep the sea for long periods without being docked. All vessels of war are in a certain sense compromises between speed, endurance, protection, and armament; no one feature can be largely developed without corresponding sacrifices in the development of the others: for example, if great speed is required, it entails machinery of great power and weight with a large supply of coal; the weights, therefore, of the other main features must necessarily be reduced in order to emphasize that of speed; therefore, when Congress has appropriated for a certain type of vessel and fixed the limit of cost, a very careful study of all existing vessels of the desired type is made by the designing staff of the construction department, the particular requirements of the service are considered, the features to be emphasized determined, and the results embodied in a carefully prepared design. It is a very usual custom, and perhaps a natural one, for the press, when the design is made public, to compare it with some similar vessel of a foreign navy whose conditions of service are very dissimilar, sometimes to the seeming disadvantage of the proposed vessel, especially when such criticism may have been suggested by private builders who desire greater latitude in certain directions, and the general public may receive the impression that the best has not been attained; but to those who know the care and study given to the preparation of the design in view of the service required, and are able to comprehend fully its military value, the conclusion is very different. Taking, then, our battle-ships, we find the highest representative in the Iowa (Fig. 1), now building at the Messrs. Cramp's, which has a displacement of 11,250 tons, and carries a battery of four

12-inch, eight 8-inch, and ten 4-inch breech-loading guns, besides twenty machine guns and six tubes for discharging 18-inch automobile torpedoes. It is one thing for a vessel to carry a large battery capable of firing a tremendous weight of metal when all the manipulating apparatus is in perfect order, but quite another in these days of high explosives to have that battery and apparatus securely protected from the guns of its antagonist, therefore the 12-inch forty-four-ton guns of the Iowa are mounted in pairs in turrets having walls of solid steel fifteen inches thick, and protected from the water-line up by steel of the same thickness, which effectually protects the loading, turning, and controlling mechanisms. In order that these guns may be fought in heavy weather the forward turret is placed on a forecastle deck with the axis of the guns some twenty-five feet above the load line, and has a train of three hundred degrees, or only sixty less than a complete circle; the after 12-inch guns are mounted in the same manner, but on a deck seven feet nearer the load line. Both forward and after turrets are placed in the mid line of the vessel, in order to have a great train and be as free as possible from the motion due to rolling; the turrets are revolved by steam power at the rate of one revolution per minute. Some idea of the power of these guns may be obtained from the following data: The weight of one powder charge is four hundred and twenty-five pounds; that of the projectile, eight hundred and fifty pounds; its muzzle velocity, 2,100 feet, or four tenths of a mile per second; the muzzle energy, 25,985 foot tons, or capable of raising that amount one foot in a minute, with a penetration in wrought iron of 27·6 inches. The 8-inch guns are also mounted in turrets, having great range, and are protected by armor varying from ten inches to seven inches and a half in thickness; the ten 4-inch guns, each discharging projectiles of thirty-six pounds weight at the rate of ten rounds per minute, are protected by fixed segmental shields four inches thick.

While so much has been done to develop the battery and its protection, the features of defense, stability, speed, and endurance have received most careful attention; the magazines, boilers, engines, steering mechanism, etc., are all inclosed in a belt of steel, covering about sixty-five per cent of the load-line area, of a maximum thickness of fourteen inches, and extending fr m three feet above to five feet below the load line; at the upper edge of this is worked from side to side of the vessel a horizontal deck three inches thick (see Figs. 2 and 3); above this, to protect the stability, a steel belt four inches in thickness is worked to the main deck, and at the unarmored ends double coffer dams six feet wide, the outer one filled with obturating and the inner one with water-excluding material, are provided as shown in Fig. 4.

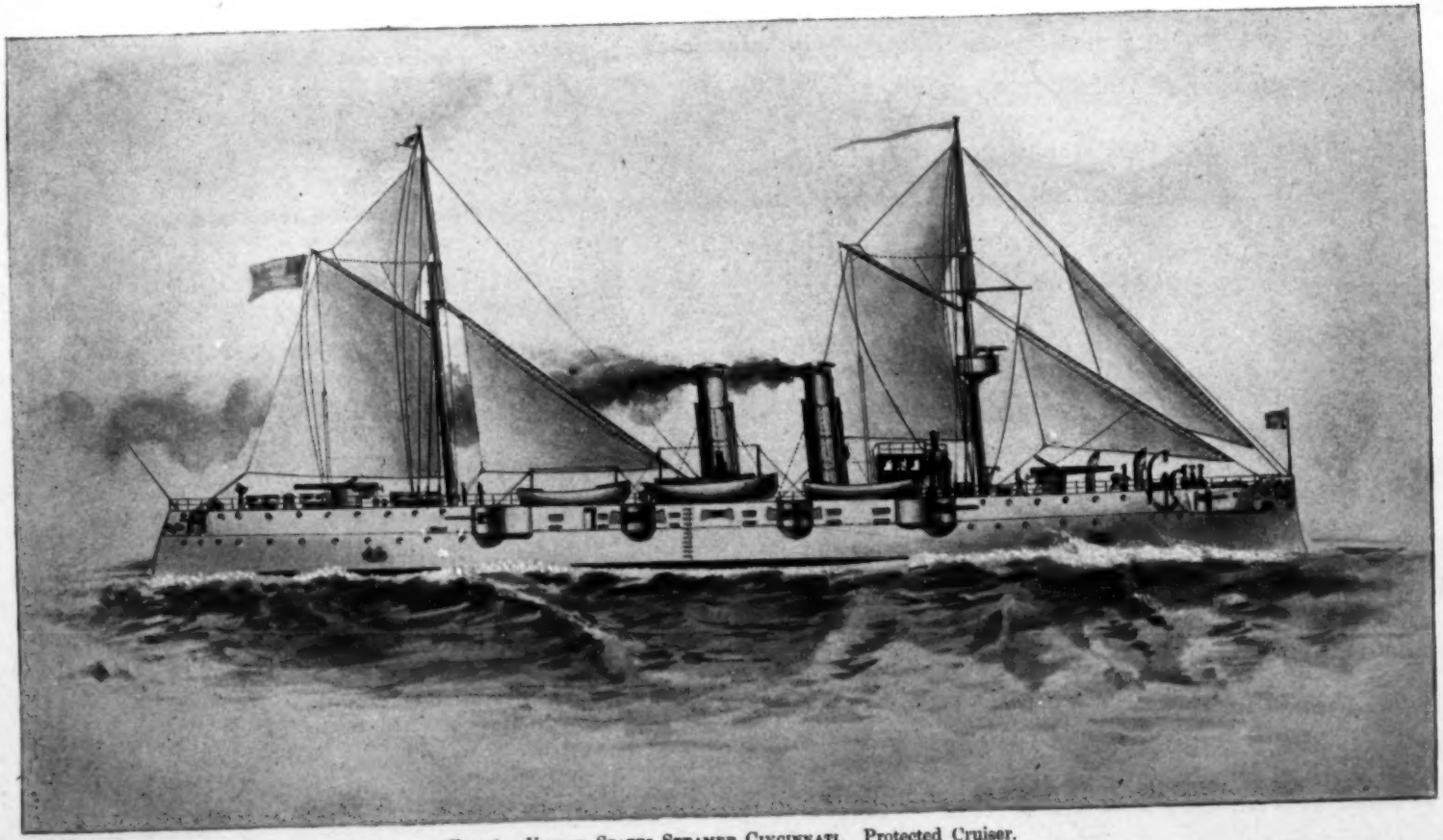


Fig. 9.—United States Steamer Cincinnati. Protected Cruiser.

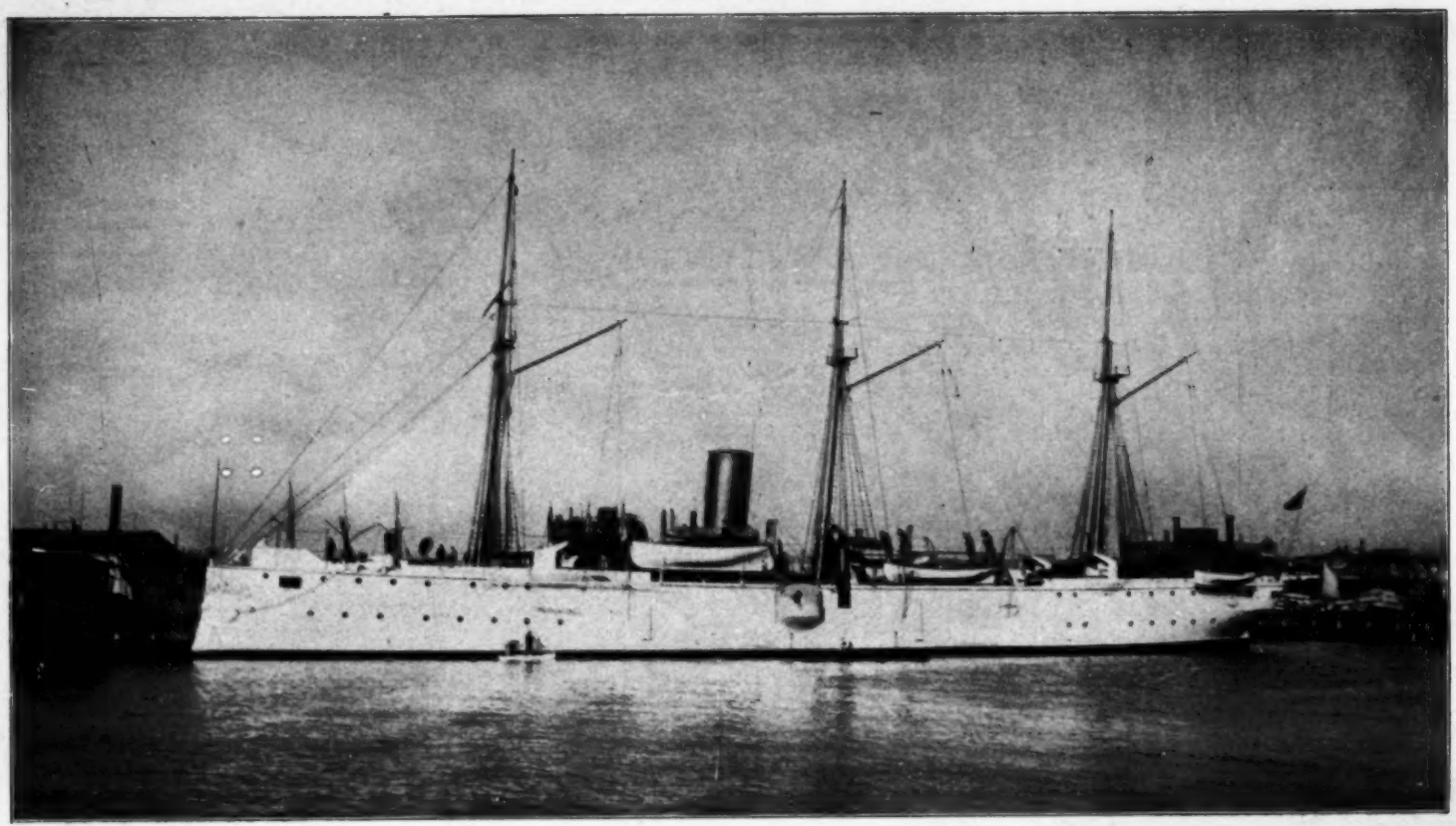


Fig. 10.—United States Steamer Yorktown. Gunboat.

Great care has been given the water-tight subdivision, both above and below the armor belt, in order to prevent a catastrophe such as that which befell the Victoria; especially above the armor belt, where the subdivision of that unfortunate vessel was very weak, has the Iowa received most careful attention. The machinery is capable of developing 11,000 horse power, and will propel the vessel at a speed of seventeen knots per hour; the engines are of the triple-expansion type, being inverted, direct acting, and surface-condensing, driving twin screws. The coal supply is sufficient when steaming at ten knots to admit of crossing the Atlantic and back without recoaling. The United States steamship New York (Fig. 5), which lately created so much enthusiasm on account of her remarkable development of speed, is of the armored-cruiser type; but the Brooklyn, now being built under contract, is a very distinct advance upon the general design of the New York, and will here be taken as the exponent of her type. We find her to be provided with sufficient power to drive her at the rate of twenty-one knots or twenty-four miles per hour, and to have a coal supply of 1,800 tons, which will give her a very large radius of action. The main battery carried is eight 8-inch and twelve 5-inch breech-loading rifles; the 8-inch guns are mounted in pairs in turrets, protected by steel armor seven and a half and five inches in thickness; the 5-inch guns and the battery of machine guns, eighteen in number, are protected by steel armor varying in thickness from four to two inches. The protection to the hull, machinery, and magazines is afforded by a steel deck of a maximum thickness of six inches, being five feet below the load line at its outboard edges, and sloping upward and inward to the height of the load line on the flat portions, as shown in Fig. 6.

Beneath this deck are placed engines, boilers, magazines, steering gear, and electrical generating plant, in fact all such parts as would be injured by and disable the vessel if exposed to the enemy's fire. To protect the stability an armored belt four inches in thickness is worked from the sloping armor to four feet above the load line for the space occupied by the engines and boilers, the object being to provide resistance sufficient to cause high-explosive shells to explode before entering the sides of the vessel. Inside of this and extending the whole length of the vessel is a coffer dam of obturating material, as shown in the outline midship section, Fig. 6, and the spaces both above and below the armor deck are closely subdivided by longitudinal and athwartship bulkheads into many compartments in which coal and stores are stowed, thus as far as possible, with the means now at the command of the naval architect, precluding the sinking of the vessel when injured.

A class of vessels of much interest, on account of their great destructive capabilities when the conditions are suitable, is the torpedo vessel, of which the Ericsson (Fig. 7), now building, is a representative; they are lightly constructed and provided with powerful machinery to enable them to attain great speed, reaching as high as twenty-eight to thirty-five miles per hour. They are armed principally with torpedo-launching tubes from which are ejected, by compressed air, automobile torpedoes, capable of traveling at a rate of speed of twenty knots per hour at a predetermined depth. The boat or launching tube is trained directly upon the target, and the torpedoes are expelled in a direct line toward it, certain automatic rudders being acted upon by hydrostatic pressure to enable them to keep their course. The head is fitted with a torpedo net-cutting device to enable the torpedo to pass through the net protecting the ship's side and to explode against the side by impact. The most noteworthy achievement by this class of vessels was the blowing up and sinking of the Blanco Encalada by the Almirante Lynch during the late Chilian struggle.

In closing this article it seems eminently proper to acknowledge the distinguished services and untiring zeal of ex-Chief Constructor Theodore D. Wilson, who for eleven years, or during the period of rehabilitation, has most ably shaped the general design and construction of the hulls of our war vessels.

EVOLUTION AND ETHICS.

By Prof. THOMAS H. HUXLEY, F. R. S.

[*Concluded.*]

LET us now set our faces westward, toward Asia Minor and Greece and Italy, to view the rise and progress of another philosophy, apparently independent, but no less pervaded by the conception of evolution.*

* In ancient times it was the fashion, even among the Greeks themselves, to derive all Greek wisdom from Eastern sources; not long ago it was as generally denied that Greek philosophy had any connection with Oriental speculation; it seems probable, however, that the truth lies between these extremes.

The Ionian intellectual movement does not stand alone. It is only one of several sporadic indications of the working of some powerful mental ferment over the whole of the area comprised between the Ægean and northern Hindustan during the eighth, seventh, and sixth centuries before our era. In these three hundred years prophetism attained its apogee among the Semites of Palestine; Zoroasterism grew and became the creed of a conquering race, the Iranic Aryans; Buddhism rose and spread with marvelous rapidity among the Aryans of Hindustan; while scientific naturalism took its rise among the Aryans of Ionia.

The sages of Miletus were pronounced evolutionists; and, however dark may be some of the sayings of Heracleitus of Ephesus, who was probably a contemporary of Gautama, no

---

It would be difficult to find another three centuries which have given birth to four events of equal importance. All the principal existing religions of mankind have grown out of the first three, while the fourth is the little spring, now swollen into the great stream of positive science. So far as physical possibilities go, the prophet Jeremiah and the oldest Ionian philosopher might have met and conversed. If they had done so they would probably have disagreed a good deal; and it is interesting to reflect that their discussions might have embraced questions which at the present day are still hotly controverted.

The old Ionian philosophy, then, seems to be only one of many results of a stirring of the moral and intellectual life of the Aryan and the Semitic populations of western Asia. The conditions of this general awakening were doubtless manifold: but there is one which modern research has brought into great prominence. This is the existence of extremely ancient and highly advanced societies in the valleys of the Euphrates and of the Nile.

It is now known that more than a thousand—perhaps more than two thousand—years before the sixth century B. C., civilization had attained a relatively high pitch among the Babylonians and the Egyptians. Not only had painting, sculpture, architecture, and the industrial arts, reached a remarkable development, but in Chaldea, at any rate, a vast amount of knowledge had been accumulated and methodized in the departments of grammar, mathematics, astronomy, and natural history. Where such tracks of the scientific spirit are visible naturalistic speculation is rarely far off, though, so far as I know, no remains of an Accadian or Egyptian philosophy, properly so called, have yet been recovered.

Geographically, Chaldea occupied a central position among the oldest seats of civilization. Commerce, largely aided by the intervention of those colossal peddlers, the Phœnicians, had brought Chaldea into connection with all of them for a thousand years before the epoch at present under consideration. And in the ninth, eighth, and seventh centuries the Assyrian, the depository of Chaldean civilization, as the Macedonian and the Roman, at a later date, were the depositories of Greek culture, had added irresistible force to the other agencies for the wide distribution of Chaldean literature, art, and science.

I confess that I find it difficult to imagine that the Greek immigrants—who stood in somewhat the same relation to the Babylonians and the Egyptians as the later Germanic barbarians to the Romans of the Empire—should not have been immensely influenced by the new life with which they became acquainted. But there is abundant direct evidence of the magnitude of this influence in certain spheres. I suppose it is not doubted that the Greek went to school with the Oriental for his primary instruction in reading, writing, and arithmetic, and that Semitic theology supplied him with some of his mythological lore. Nor does there now seem to be any question about the large indebtedness of Greek art to that of Chaldea and that of Egypt.

But the manner of that indebtedness is very instructive. The obligation is clear, but its limits are no less definite. Nothing better exemplifies the indomitable originality of the Greeks than the relations of their art to that of the Orientals. Far from being subdued into mere imitators by the technical excellence of their teachers, they lost no time in bettering the instruction they received, using their models as mere stepping-stones on the way to those unsurpassed and unsurpassable achievements which are all their own. The shibboleth of Art is the human figure. The ancient Chaldeans and Egyptians, like the modern Japanese, did wonders in the representation of birds and quadrupeds; they even attained to something more than respectability in human portraiture. But their utmost efforts never brought them within range of the best Greek embodiments of the grace of womanhood, or of the severer beauty of manhood.

It is worth while to consider the probable effect upon the acute and critical Greek mind of the conflict of ideas, social, political, and theological, which arose out of the conditions

better expressions of the essence of the modern doctrine of evolution can be found than are presented by some of his pithy aphorisms and striking metaphors.* Indeed, many of my present

---

of life in the Asiatic colonies. The Ionian polities had passed through the whole gamut of social and political changes, from patriarchal and occasionally oppressive kingship to rowdy and still more burdensome mobship—no doubt with infinitely eloquent and copious argumentation on both sides at every stage of their progress toward that arbitrament of force which settles most political questions. The marvelous speculative faculty, latent in the Ionian, had come in contact with Mesopotamian, Egyptian, Phœnician theologies and cosmogonies; with the illuminati of Orphism and the fanatics and dreamers of the Mysteries; possibly with Buddhism and Zoroasterism; possibly even with Judaism. And it has been observed that the mutual contradictions of antagonistic supernaturalisms are apt to play a large part among the generative agencies of naturalism.

Thus, various external influences may have contributed to the rise of philosophy among the Ionian Greeks of the sixth century. But the assimilative capacity of the Greek mind—its power of Hellenizing whatever it touched—has here worked so effectually that, so far as I can learn, no indubitable traces of such extraneous contributions are now allowed to exist by the most authoritative historians of philosophy. Nevertheless, I think it must be admitted that the coincidences between the Heracleito-stoical doctrines and those of the older Hindu philosophy are extremely remarkable. In both the cosmos pursues an eternal succession of cyclical changes. The great year, answering to the Kalpa, covers an entire cycle from the origin of the universe as a fluid to its dissolution in fire—"Humor initium, ignis exitus mundi," as Seneca has it. In both systems there is immanent in the cosmos a source of energy, Brahma, or the Logos, which works according to fixed laws. The individual soul is an efflux of this world-spirit, and returns to it. Perfection is attainable only by individual effort through ascetic discipline, and is rather a state of painlessness than of happiness, if indeed it can be said to be a state of anything save the negation of perturbing emotion. The hatchment motto "In Cœlo Quies" would serve both Hindu and Stoic, and absolute quiet is not easily distinguishable from annihilation.

Zoroasterism, which geographically occupies a position intermediate between Hellenism and Hinduism, agrees with the latter in recognizing the essential evil of the cosmos, but differs from both in its intensely anthropomorphic personification of the two antagonistic principles, to the one of which it ascribes all the good, and to the other all the evil. In fact, it assumes the existence of two worlds, one good and one bad; the latter created by the evil power for the purpose of damaging the former. The existing cosmos is a mere mixture of the two, and the "last judgment" is a root and branch extirpation of the work of Ahriman.

* There is no snare in which the feet of a modern student of ancient lore are more easily entangled than that which is spread by the similarity of the language of antiquity to modern modes of expression. I do not presume to interpret the obscurest of Greek philosophers; all I wish is to point out that his words, in the sense accepted by competent interpreters, fit modern ideas singularly well.

So far as the general theory of evolution goes, there is no difficulty. The aphorism about the river; the figure of the child playing on the shore; the kingship and fatherhood of strife, seem decisive. The ὁδὸς ἄνω κάτω μία expresses with singular aptness the cyclical aspect of the one process of organic evolution in individual plants and animals; yet it may be a question whether the Heracleitean strife included any distinct conception of the struggle for existence. Again, it is tempting to compare the part played by the Heracleitean "fire" with that ascribed by the moderns to heat, or rather to that cause of motion of which heat is one expression; and a little ingenuity might find a foreshadowing of the doctrine of the conservation of energy in the saying that all the things are changed into fire and fire into all things, as gold into goods and goods into gold.

auditors must have observed that more than once I have borrowed from him in the brief exposition of the theory of evolution with which this discourse commenced.

But when the focus of Greek intellectual activity shifted to Athens, the leading minds concentrated their attention upon ethical problems. For saking the study of themacrocosm for that of the microcosm, they lost the key to the thought of the great Ephesian, which I imagine is more intelligible to us than it was to Socrates or to Plato. Socrates more especially set the fashion of a kind of inverse agnosticism, by teaching that the problems of physics lie beyond the reach of the human intellect; that the attempt to solve them is essentially vain; that the one worthy object of investigation is the problem of ethical life; and his example was followed by the Cynics and the later Stoics. Even the comprehensive knowledge and the penetrating intellect of Aristotle failed to suggest to him that in holding the eternity of the world within its present range of mutation, he was making a retrogressive step. The scientific heritage of Heracleitus passed into the hands neither of Plato nor of Aristotle, but into those of Democritus. But the world was not yet ready to receive the great conceptions of the philosopher of Abdera. It was reserved for the Stoics to return to the track marked out by the earlier philosophers, and, professing themselves disciples of Heracleitus, to develop the idea of evolution systematically. In doing this, they not only omitted some characteristic features of their master's teaching, but they made additions altogether foreign to it. One of the most influential of these importations was the transcendental theism which had come into vogue. The restless, fiery energy, operating according to law, out of which all things emerge and into which they return, in the endless successive cycles of the great year; which creates and destroys worlds as a wanton child builds up and, anon, levels sand castles on the seashore, was metamorphosed into a material world-soul, and decked out with all the attributes of ideal Divinity; not merely with infinite power and transcendent wisdom, but with absolute goodness.

The consequences of this step were momentous; for, if the cosmos is the effect of an immanent, omnipotent, and infinitely beneficent cause, the existence in it of real evil, still less of necessarily inherent evil, is plainly inadmissible.* Yet the universal

---

* Pope's lines in the Essay on Man (Ep. i, 267, 268),

> "All are but parts of one stupendous whole,
> Whose body Nature is, and God the soul,"

simply paraphrase Seneca's "quem in hoc mundo locum deus obtinet, hunc in homine animus: quod est illic materia, id nobis corpus est" (Ep. lxv, 24) [And what God is in the world, such is the mind or soul in man; what in the world is *matter*, in us is body.—

experience of mankind testified then as now that, whether we look within us or without us, evil stares us in the face on all sides; that if anything is real, pain and sorrow and wrong are realities.

It would be a new thing in history if *a priori* philosophers were daunted by the factious opposition of experience, and the Stoics were the last men to allow themselves to be beaten by mere facts. "Give me a doctrine and I will find the reasons for it," said Chrysippus. So they perfected, if they did not invent, that ingenious and plausible form of pleading, the Theodicy, for the purpose of showing, firstly, that there is no such thing as evil; secondly, that if there is, it is the necessary correlate of good; and moreover, that it is either due to our own fault or inflicted for our benefit. Theodicies have been very popular in their time, and I believe that a numerous, though somewhat dwarfed, progeny of them still survives. So far as I know, they are all variations of the theme set forth in those famous six lines of the Essay on Man, in which Pope sums up Bolingbroke's reminiscences of stoical and other speculations of this kind:

> "All nature is but art, unknown to thee;
> All chance, direction which thou canst not see;
> All discord, harmony not understood;
> All partial evil, universal good;
> And spite of pride, in erring reason's spite,
> One truth is clear: whatever is is right."

Yet surely, if there are few more important truths than those enunciated in the first triad, the second is open to very grave objections. That there is a "soul of good in things evil" is unquestionable; nor will any wise man deny the disciplinary value of pain and sorrow. But these considerations do not help us to see why the immense multitude of irresponsible sentient beings which can not profit by such discipline should suffer; nor why, among the endless possibilities open to omnipotence—that of sinless, happy existence among the rest—the actuality in which sin and misery abound should be that selected. Surely it is mere cheap rhetoric to call arguments which have never yet been answered

---

Morell's translation], which again is a Latin version of the old Stoical doctrine, *εἰς ἄκρον τοῦ κόσμου μέρος διήκει ὁ νοῦς, καθάπερ ἀφ' ἡμῶν ἡ ψυχή.*

So far as testimony for the universality of what ordinary people call "evil" goes, there is nothing better than the writings of the Stoics themselves. They might serve as a storehouse for the epigrams of the ultra-pessimists. Heraclitus (*circa* 500 B. C.) says just as hard things about ordinary humanity as his disciples centuries later; and there really seems no need to seek for the causes of this dark view of life in the circumstances of the time of Alexander's successors or of the early emperors of Rome. To the man with an ethical ideal, the world, including himself, will always seem full of evil.

by even the meekest and the least rational of optimists suggestions of the pride of reason. As to the concluding aphorism, its fittest place would be as an inscription in letters of mud over the portal of some "stye of Epicurus";* for that is where the logical application of it to practice would land men, with every aspiration stifled and every effort paralyzed. Why try to set right what is right already? Why strive to improve the best of all possible worlds? Let us eat and drink, for as to-day all is right, so to-morrow all will be.

But the attempt of the Stoics to blind themselves to the reality of evil, as a necessary concomitant of the cosmic process, had less success than that of the Indian philosophers to exclude the reality of good from their purview. Unfortunately, it is much easier to shut one's eyes to good than to evil. Pain and sorrow knock at our doors more loudly than pleasure and happiness, and the prints of their heavy footsteps are less easily effaced. Before the grim realities of practical life the pleasant fictions of optimism vanished. If this were the best of all possible worlds, it nevertheless proved itself a very inconvenient habitation for the ideal sage.

The stoical summary of the whole duty of man, "Live according to Nature," would seem to imply that the cosmic process is an exemplar for human conduct. Ethics would thus become applied natural history. In fact, a confused employment of the maxim in this sense has done immeasurable mischief in later times. It has furnished an axiomatic foundation for the philosophy of philosophasters and for the moralizing of sentimentalists. But the Stoics were, at bottom, not merely noble but sane men; and if we look closely into what they really meant by this ill-used phrase, it will be found to present no justification for the mischievous conclusions that have been deduced from it.

In the language of the Stoa, "Nature" was a word of many meanings. There was the "Nature" of the cosmos and the "Nature" of man. In the latter, the animal "nature," which man shares with a moiety of the living part of the cosmos, was distinguished from a higher "nature." Even in this higher nature there were grades of rank. The logical faculty is an instrument which may be turned to account for any purpose. The passions and the emotions are so closely tied to the lower nature that they may be considered to be pathological rather than normal phenomena. The one supreme, hegemonic faculty which con-

* I use the well-known phrase, but decline responsibility for the libel upon Epicurus, whose doctrines were far less compatible with existence in a stye than those of the Cynics. If it were steadily borne in mind that the conception of the "flesh" as the source of evil, and that the great saying, "Initium est salutis notitia peccati" [the beginning of salvation is the recognition of sin], are the property of Epicurus, fewer illusions about Epicureanism would pass muster for accepted truth.

stitutes the essential "nature" of man, is most nearly represented by that which, in the language of a later philosophy, has been called the pure reason. It is this "nature" which holds up the ideal of the supreme good and demands absolute submission of the will to its behests. It is this which commands all men to love one another, to return good for evil, to regard one another as fellow-citizens of one great state. Indeed, seeing that the progress toward perfection of a civilized state, or polity, depends on the obedience of its members to these commands, the Stoics sometimes termed the pure reason the "political" nature. Unfortunately, the sense of the adjective has undergone so much modification that the application of it to that which commands the sacrifice of self to the common good would now sound almost grotesque.*

But what part is played by the theory of evolution in this view of ethics? So far as I can discern, the ethical system of the Stoics, which is essentially intuitive, and reverences the categorical imperative as strongly as that of any later moralists, might have been just what it was if they had held any other theory—whether that of special creation, on the one side, or that of the eternal existence of the present order, on the other.† To the Stoic, the

---

* The Stoics said that man was a ζῷον λογικὸν πολιτικὸν φιλάλληλον, or a rational, a political, and an altruistic or philanthropic animal. In their view, his higher nature tended to develop in these three directions as a plant tends to grow up into its typical form. Since, without the introduction of any consideration of pleasure or pain, whatever thwarted the realization of its type by the plant might be said to be bad, and whatever helped it good; so virtue, in the Stoical sense, as the conduct which tended to the attainment of the rational, political, and philanthropic ideal, was good in itself and irrespectively of its emotional concomitants.

Man is an "animal sociale communi bono genitum." The safety of society depends upon practical recognition of the fact. "Salva autem esse societas nisi custodia et amore partium non possit," says Seneca. (De Ira, ii, 31.) [The safety of society depends upon the love and care of its component parts.]

† The importance of the physical doctrine of the Stoics lies in its clear recognition of the universality of the law of causation with its corollary, the order of Nature: the exact form of that order is an altogether secondary consideration.

Many ingenious persons now appear to consider that the incompatibility of pantheism, of materialism, and of any doubt about the immortality of the soul, with religion and morality, is to be held as an axiomatic truth. I confess that I have a certain difficulty in accepting this dogma. For the Stoics were notoriously materialists and pantheists of the most extreme character; and while no strict stoic believed in the eternal duration of the individual soul, some even denied its persistence after death. Yet it is equally certain that of all Gentile philosophies, Stoicism exhibits the highest ethical development, is animated by the most religious spirit, and has exerted the profoundest influence upon the moral and religious development not merely of the best men among the Romans, but among the moderns down to our own day.

Seneca was claimed as a Christian and placed among the saints by the fathers of the early Christian Church; and the genuineness of a correspondence between him and the apostle Paul has been hotly maintained in our own time by orthodox writers. That the

cosmos had no importance for the conscience, except in so far as he chose to think it a pedagogue to virtue. The pertinacious optimism of our philosophers hid from them the actual state of the case. It prevented them from seeing that cosmic nature is no school of virtue, but the headquarters of the enemy of ethical nature. The logic of facts was necessary to convince them that the cosmos works through the lower nature of man, not for righteousness, but against it. And it finally drove them to confess that the existence of their ideal "wise man" was incompatible with the nature of things; that even a passable approximation to that ideal was to be attained only at the cost of renunciation of the world and mortification, not merely of the flesh, but of all human affections. The state of perfection was that "apatheia"* in which desire, though it may still be felt, is powerless to move the will, reduced to the sole function of executing the commands of pure reason. Even this residuum of activity was to be regarded as a temporary loan—as an efflux of the divine, world-pervading spirit, chafing at its imprisonment in the flesh, until such time as death enabled it to return to its source in the all-pervading logos.

I find it difficult to discover any very great difference between Apatheia and Nirvana, except that stoical speculation agrees with

---

letters, as we possess them, are worthless forgeries is obvious, and writers as wide apart as Baur and Lightfoot agree that the whole story is devoid of foundation.

The dissertation of the late Bishop of Durham (Lightfoot, Epistle to the Philippians) is particularly worthy of study, apart from this question, on account of the evidence which it supplies of the numerous similarities of thought between Seneca and the writer of the Pauline epistles. When it is remembered that the writer of the Acts puts a quotation from Aratus, or Cleanthes, into the mouth of the apostle, and that Tarsus was a great seat of philosophical and especially stoical learning (Chrysippus himself was a native of the adjacent town of Sôli) there is no difficulty in understanding the origin of these resemblances. See, on this subject, Sir Alexander Grant's dissertation in his edition of The Ethics of Aristotle (where there is an interesting reference to the stoical character of Bishop Butler's ethics), the concluding pages of Dr. Weygoldt's instructive little work, Die Philosophie der Stoa, and Aubertin's Sénèque et Saint Paul.

It is surprising that a writer of Dr. Lightfoot's stamp should speak of Stoicism as a philosophy of "despair." Surely, rather, it was a philosophy of men who, having cast off all illusions and the childishness of despair among them, were minded to endure in patience whatever conditions the cosmic process might create, so long as those conditions were compatible with the progress toward virtue, which alone for them conferred a worthy object on existence. There is no note of despair in the stoical declaration that the perfected "wise man" is the equal of Zeus in everything but the duration of his existence. And in my judgment there is as little pride about it—often as it serves for the text of discourses on stoical arrogance. Grant the stoical postulate that there is no good except virtue; grant that the perfected wise man is altogether virtuous, in consequence of being guided in all things by the reason, which is an effluence of Zeus, and there seems no escape from the stoical conclusion.

* Our "apathy" carries such a different set of connotations from its Greek original that I have ventured on using the latter as a technical term.

pre-Buddhistic philosophy, rather than with the teachings of Gautama, in so far as it postulates a permanent substance equivalent to "Brahma" and "Atman"; and that, in stoical practice, the adoption of the life of the mendicant cynic was held to be more a counsel of perfection than an indispensable condition of the higher life.

Thus the extremes touch. Greek thought and Indian thought set out from ground common to both, diverge widely, develop under very different physical and moral conditions, and finally converge to practically the same end.

The Vedas and the Homeric epos set before us a world of rich and vigorous life, full of joyous fighting men—

> "That ever with a frolic welcome took
> The thunder and the sunshine," . . . .

and who were ready to brave the very gods themselves when their blood was up. A few centuries pass away and, under the influence of civilization, the descendants of these men are "sicklied o'er with the pale cast of thought"—frank pessimists, or at best, make-believe optimists. The courage of the warlike stock may be as hardly tried as before, perhaps more hardly, but the enemy is self. The hero has become a monk. The man of action is replaced by the quietist, whose highest aspiration is to be the passive instrument of the divine Reason. By the Tiber, as by the Ganges, ethical man admits that the cosmos is too strong for him; and, destroying every bond which ties him to it by ascetic discipline, he seeks salvation in absolute renunciation.*

Modern thought is making a fresh start from the base whence Indian and Greek philosophy set out; and, the human mind being very much what it was six and twenty centuries ago, there is no ground for wonder if it presents indications of a tendency to move along the old lines to the same results.

We are more than sufficiently familiar with modern pessimism, at least as a speculation; for I can not call to mind that any of its present votaries have sealed their faith by assuming the rags and the bowl of the mendicant Bhikku, or the cloak and the wallet of the Cynic. The obstacles placed in the way of sturdy vagrancy by an unphilosophical police have, perhaps, proved too formidable for philosophical consistency. We also know modern speculative

---

* Many of the stoical philosophers recommended their disciples to take an active share in public affairs, and in the Roman world, for several centuries, the best public men were strongly inclined to Stoicism. Nevertheless, the logical tendency of Stoicism seems to me to be fulfilled only in such men as Diogenes and Epictetus.

optimism, with its perfectibility of the species, reign of peace, and lion and lamb transformation scenes; but one does not hear so much of it as one did forty years ago; indeed, I imagine it is to be met with more commonly at the tables of the healthy and wealthy than in the congregations of the wise. The majority of us, I apprehend, profess neither pessimism nor optimism. We hold that the world is neither so good nor so bad as it conceivably might be, and as most of us have reason, now and again, to discover that it can be. Those who have failed to experience the joys that make life worth living are, probably, in as small a minority as those who have never known the griefs that rob existence of its savor and turn its richest fruits into mere dust and ashes.

Further, I think I do not err in assuming that, however diverse their views on philosophical and religious matters, most men are agreed that the proportion of good and evil in life may be very sensibly affected by human action. I never heard anybody doubt that the evil may be thus increased or diminished, and it would seem to follow that good must be similarly susceptible of addition or subtraction. Finally, to my knowledge, nobody professes to doubt that, so far forth as we possess a power of bettering things, it is our paramount duty to use it and to train all our intellect and energy to this supreme service of our kind.

Hence the pressing interest of the question, to what extent modern progress in natural knowledge and, more especially, the general outcome of that progress in the doctrine of evolution, is competent to help us in the great work of helping one another.

The propounders of what are called the "ethics of evolution," when the "evolution of ethics" would usually better express the object of their speculations, adduce a number of more or less interesting facts and more or less sound arguments, in favor of the origin of the moral sentiments, in the same way as other natural phenomena, by a process of evolution. I have little doubt, for my own part, that they are on the right track; but as the immoral sentiments have no less been evolved, there is so far as much natural sanction for the one as the other. The thief and the murderer follow Nature just as much as the philanthropist. Cosmic evolution may teach us how the good and the evil tendencies of man may have come about, but in itself it is incompetent to furnish any better reason why what we call good is preferable to what we call evil than we had before. Some day, I doubt not, we shall arrive at an understanding of the evolution of the æsthetic faculty; but all the understanding in the world will neither increase nor diminish the force of the intuition that this is beautiful and that is ugly.

There is another fallacy which appears to me to pervade the so-called "ethics of evolution." It is the notion that because, on the whole, animals and plants have advanced in perfection of organization by means of the struggle for existence and the consequent "survival of the fittest"; therefore men in society, men as ethical beings, must look to the same process to help them toward perfection. I suspect that this fallacy has arisen out of the unfortunate ambiguity of the phrase "survival of the fittest." "Fittest" has a connotation of "best," and about "best" there hangs a moral flavor. In cosmic Nature, however, what is "fittest" depends upon the conditions. Long since, I ventured to point out that if our hemisphere were to cool again, the survival of the fittest might bring about, in the vegetable kingdom, a population of more and more stunted and humbler and humbler organisms, until the "fittest" that survived might be nothing but lichens, diatoms, and such microscopic organisms as those which give red snow its color; while, if it became hotter, the pleasant valleys of the Thames and Isis might be uninhabitable by any animated beings save those that flourish in a tropical jungle. They, as the fittest, the best adapted to the changed conditions, would survive.

Men in society are undoubtedly subject to the cosmic process. As among other animals, multiplication goes on without cessation and involves severe competition for the means of support. The struggle for existence tends to eliminate those less fitted to adapt themselves to the circumstances of their existence. The strongest, the most self-assertive, tend to tread down the weaker. But the influence of the cosmic process on the evolution of society is the greater the more rudimentary its civilization. Social progress means a checking of the cosmic process at every step and the substitution for it of another, which may be called the ethical process; the end of which is not the survival of those who may happen to be the fittest, in respect of the whole of the conditions which exist, but of those who are ethically the best.*

* Of course, strictly speaking, social life and the ethical process, in virtue of which it advances toward perfection, are part and parcel of the general process of evolution, just as the gregarious habit of innumerable plants and animals, which has been of immense advantage to them, is so. A hive of bees is an organic polity—a society in which the part played by each member is determined by organic necessities. Queens, workers, and drones are, so to speak, castes, divided from one another by marked physical barriers. Among birds and mammals, societies are formed, of which the bond in many cases seems to be purely psychological; that is to say, it appears to depend upon the liking of the individuals for one another's company. The tendency of individuals to over self-assertion is kept down by fighting. Even in these rudimentary forms of society, love and fear come into play and enforce a greater or less renunciation of self-will. To this extent the general cosmic process begins to be checked by a rudimentary ethical process, which is, strictly speaking, part of the former just as the "governor" in a steam engine is part of the mechanism of the engine.

As I have already urged, the practice of that which is ethically best—what we call goodness or virtue—involves a course of conduct which, in all respects, is opposed to that which leads to success in the cosmic struggle for existence. In place of ruthless self-assertion it demands self-restraint; in place of thrusting aside, or treading down, all competitors, it requires that the individual shall not merely respect, but shall help his fellows; its influence is directed, not so much to the survival of the fittest, as to the fitting of as many as possible to survive. It repudiates the gladiatorial theory of existence. It demands that each man who enters into the enjoyment of the advantages of a polity shall be mindful of his debt to those who have laboriously constructed it; and shall take heed that no act of his weakens the fabric in which he has been permitted to live. Laws and moral precepts are directed to the end of curbing the cosmic process and reminding the individual of his duty to the community, to the protection and influence of which he owes, if not existence itself, at least the life of something better than a brutal savage.

It is from neglect of these plain considerations that the fanatical individualism of our time attempts to apply the analogy of cosmic Nature to society. Once more we have a misapplication of the stoical injunction to follow Nature; the duties of the individual to the state are forgotten and his tendencies to self-assertion are dignified by the name of rights. It is seriously debated whether the members of a community are justified in using their combined strength to constrain one of their number to contribute his share to the maintenance of it; or even to prevent him from doing his best to destroy it. The struggle for existence, which has done such admirable work in cosmic Nature, must, it appears, be equally beneficent in the ethical sphere. Yet, if that which I have insisted upon is true; if the cosmic process has no sort of relation to moral ends; if the imitation of it by man is inconsistent with the first principles of ethics; what becomes of this surprising theory?

Let us understand, once for all, that the ethical progress of society depends, not on imitating the cosmic process, still less in running away from it, but in combating it. It may seem an audacious proposal thus to pit the microcosm against the macrocosm and to set man to subdue Nature to his higher ends; but, I venture to think that the great intellectual difference between the ancient times with which we have been occupied and our day, lies in the solid foundation we have acquired for the hope that such an enterprise may meet with a certain measure of success.

The history of civilization details the steps by which men have succeeded in building up an artificial world within the cosmos. Fragile reed as he may be, man, as Pascal says, is a thinking

reed:* there lies within him a fund of energy, operating intelligently and so far akin to that which pervades the universe, that it is competent to influence and modify the cosmic process. In virtue of his intelligence, the dwarf bends the Titan to his will. In every family, in every polity that has been established, the cosmic process in man has been restrained and otherwise modified by law and custom; in surrounding Nature, it has been similarly influenced by the art of the shepherd, the agriculturist, the artisan. As civilization has advanced, so has the extent of this interference increased; until the organized and highly developed sciences and arts of the present day have endowed man with a command over the course of non-human nature greater than that once attributed to the magicians. The most impressive, I might say startling, of these changes have been brought about in the course of the last two centuries; while a right comprehension of the process of life and of the means of influencing its manifestations is only just dawning upon us. We do not yet see our way beyond generalities; and we are befogged by the obtrusion of false analogies and crude anticipations. But Astronomy, Physics, Chemistry, have all had to pass through similar phases, before they reached the stage at which their influence became an important factor in human affairs. Physiology, Psychology, Ethics, Political Science, must submit to the same ordeal. Yet it seems to me irrational to doubt that, at no distant period, they will work as great a revolution in the sphere of practice.

The theory of evolution encourages no millennial anticipations. If, for millions of years, our globe has taken the upward road, yet, some time, the summit will be reached and the downward route will be commenced. The most daring imagination will hardly venture upon the suggestion that the power and the intelligence of man can ever arrest the procession of the great year.

Moreover, the cosmic nature born with us and, to a large extent, necessary for our maintenance, is the outcome of millions of years of severe training, and it would be folly to imagine that a few centuries will suffice to subdue its masterfulness to purely ethical ends. Ethical nature may count upon having to reckon

---

* "L'homme n'est qu'un roseau, le plus faible de la nature, mais c'est un roseau pensant. Il ne faut pas que l'univers entier s'arme pour l'écraser. Une vapeur, une goutte d'eau, suffit pour le tuer. Mais quand l'univers l'écraserait, l'homme serait encore plus noble que ce qui le tue, parce qu'il sait qu'il meurt; et l'avantage que l'univers a sur lui, l'univers n'en sait rien."—*Pensées de Pascal*, chap. ii, x. [Man is but a reed, weakest in Nature, but a reed which thinks. It needs not that the whole Universe should arm to crush him. But were the Universe to crush him, man would still be more noble than that which has slain him, because he knows that he dies, and that the Universe has the better of him. The Universe knows nothing of this.—*Bohn's translation.*]

with a tenacious and powerful enemy as long as the world lasts. But, on the other hand, I see no limit to the extent to which intelligence and will, guided by sound principles of investigation, and organized in common effort, may modify the conditions of existence, for a period longer than that now covered by history. And much may be done to change the nature of man himself. The intelligence which has converted the brother of the wolf into the faithful guardian of the flock ought to be able to do something toward curbing the instincts of savagery in civilized men.

But if we may permit ourselves a larger hope of abatement of the essential evil of the world than was possible to those who, in the infancy of exact knowledge, faced the problem of existence more than a score of centuries ago, I deem it an essential condition of the realization of that hope that we should cast aside the notion that the escape from pain and sorrow is the proper object of life.

We have long since emerged from the heroic childhood of our race, when good and evil could be met with the same "frolic welcome"; the attempts to escape from evil, whether Indian or Greek, have ended in flight from the battle-field; it remains to us to throw aside the youthful overconfidence and the no less youthful discouragement of nonage. We are grown men, and must play the man

> "strong in will
> To strive, to seek, to find, and not to yield,"

cherishing the good that falls in our way and bearing the evil, in and around us, with stout hearts set on diminishing it. So far, we all may strive in one faith toward one hope:

> "It may be that the gulfs will wash us down,
> It may be we shall touch the Happy Isles,
>
> "... but something ere the end,
> Some work of noble note may yet be done." *

"TEACH, and let the examination take care of itself," was the advice given by Mr. A. E. Hawkins, in his Notes on Science Teaching in the Public Schools, read in the British Association. In his experience he had found that a little knowledge went a long way in an examination. If necessary, the experiments of the lecture could be performed by one of the boys, the rest watching him; but it was better that all the boys should make experiments, preferably working in pairs.

---

* A great proportion of poetry is addressed by the young to the young; only the great masters of the art are capable of divining, or think it worth while to enter into, the feelings of retrospective age. The two great poets whom we have so lately lost, Tennyson and Browning, have done this, each in his own inimitable way; the one in the Ulysses, from which I have borrowed; the other in that wonderful fragment, Childe Roland to the dark Tower came.

EVOLUTIONARY ETHICS.

THE preceding article concludes Prof. Huxley's famous Romanes Address, the first part of which was given in The Popular Science Monthly for November. As bearing on the author's main contention that the ethical progress of society is opposed to the cosmic process of evolution, the following letter will be read with interest.—ED.

To the Editor of The Popular Science Monthly:

SIR: He who crosses swords with Prof. Huxley in a dialectical encounter takes his life in both hands. I am not unaware, therefore, of my temerity in entering the lists against a scholar so fully equipped on all subjects; and my timidity is greatly increased when I venture to question his interpretation of the law of the "survival of the fittest," a subject upon which he is universally recognized as an authority. Yet it is because of what I deem to be a misinterpretation of that law that goes to the very marrow of a recent discussion by him that I venture to differ with him.

In his exceedingly thoughtful and suggestive Romanes Lecture on Evolution and Ethics, Prof. Huxley maintains that the cosmic process of evolution is directly opposed to the ethical development of mankind, "that the cosmic process has no sort of relation to moral ends" [see this number of the MONTHLY, p. 189], and that the struggle for existence and the survival of the fittest can never help man toward ethical perfection. "Social progress," he says, "means a checking of the cosmic process at every step, and the substitution for it of another, which may be called the ethical process; the end of which is not the survival of those who may happen to be the fittest, in respect of the whole of the conditions which exist, but of those who are ethically the best. As I have already urged, the practice of that which is ethically best—what we call goodness or virtue—involves a course of conduct which, in *all* [the Italics are mine] respects, is opposed to that which leads to success in the cosmic struggle for existence. In place of ruthless self-assertion it demands self-restraint; in place of thrusting aside, or treading down, all competitors, it requires that the individual shall not merely respect, but shall help his fellows; its influence is directed not so much to the survival of the fittest, as to the fitting of as many as possible to survive" [pp. 188, 189]. Holding these views it is to be expected that Prof. Huxley should describe man's development in the following words: "Man, the animal, in fact, has worked his way to the headship of the sentient world, and has become the superb animal

which he is, in virtue of his success in the struggle for existence. The conditions having been of a certain order, man's organization has adjusted itself to them better than that of his competitors in the cosmic strife. In the case of mankind the self-assertion, the unscrupulous seizing on all that can be grasped, the tenacious holding of all that can be kept, which constitute the essence of the struggle for existence, have answered" [November MONTHLY, pp. 21, 22].

Are the qualities here emphasized the only essential ones? Does this statement include all the facts or cover the whole truth? To me it seems to be far from doing this, although it states clearly and vigorously what all must admit to be partially true.

The benefits of co-operation in the development of man are too well recognized to be denied. Physically weaker than many of the animals that surrounded him, he could not long have survived in a struggle for existence against them had he been forced to continue that struggle alone. Nor could he have attained the mental development upon which so much of his success has depended without contact with his fellows. The most important if not the necessary condition of man's success in the struggle for existence is society. Social growth becomes possible only through the survival of the *socially fit*. In an advancing society this process must ever tend toward the production and preservation of the "ethically best." Recognition of the rights of others has been equally as important in the evolution of man as self-assertion. Indeed, it may be claimed that, under the conditions of social life, it is a necessary consequence of self-assertion. Men could not live long together unless they recognized the right of each to his own, and respected it. The survival of a society, like the survival of the individuals composing it, becomes possible only through adaptation to the *necessary* conditions of life, and it will not be denied by Prof. Huxley that morality is essential to social well-being. Indeed, he admits as much, for he says: "One of the oldest and most important elements in such systems is the conception of justice. Society is impossible unless those who are associated agree to observe certain rules of conduct toward one another; its stability depends on the steadiness with which they abide by that agreement; and so far as they waver, that mutual trust which is the bond of society is weakened or destroyed" [November MONTHLY, p. 24].

I am somewhat at a loss to reconcile this statement with the general teaching of the lecture. It seems to me that this moral development is just as much a part of the "cosmic process" as physical or mental development, neither of which are excluded by Prof. Huxley. Moral development comes, to be sure, in recognizable quantities, rather later in history than the others, and is of

greater consequence in a high civilization than in a low; is, indeed, or ought to be, considered one of the principal signs of the existence of the former. While it was essential in even the lowest form of social organization, it was for a long period of less apparent importance. The earlier struggles for existence were chiefly intertribal or international, and in these the qualities emphasized by Prof. Huxley as necessary for success were undoubtedly predominant. While the struggle still goes on in this form, it no longer occupies the time and attention of mankind to the same extent as formerly. Among civilized societies at least the struggle for existence has also taken on another form, and the conditions of success have greatly changed. Industrial competition has taken the place of war, and notwithstanding that the theories and the methods of international conflict are still somewhat potent in this field, they are so mostly because our ethical, and, for that matter, even our intellectual, training has not gone far enough. It can not be denied that the reign of industrialism, or at least the absence of war, has softened the manners if it has not changed the character of men. Prof. Huxley himself bears witness to this, for he says, "The cosmic nature born with us and, to a large extent, necessary for our maintenance, is the outcome of millions of years of severe training, and it would be folly to imagine that a few centuries will suffice to subdue its masterfulness to purely ethical ends" [p. 190].

It can, however, be shown, I think, that those societies will become the victors in the struggle for industrial supremacy, who are mentally and morally the most highly developed, or, in other words, socially the fittest. In an article on Ethics and Economics, published in The Popular Science Monthly for October, 1888, I have discussed this proposition at some length, but the following quotation will, I think, answer my present purpose:

"For the purpose in hand, we desire to call attention to the necessity of basing our political economy on moral rather than on selfish instincts. Powerful though the latter be, they are more or less anti-social in their nature, and therefore would not of themselves favor economic growth. That depends for its development on social growth, and it is only when the selfish instincts are held in due check and subordination to the higher impulses that the latter is possible. Strength, keenness, and shrewdness are important factors in determining the survival of the individual, and, in so far as they do this, they favor also the survival of the race. But of more importance still are those traits which, by enabling men to live together in peace, render possible the organization of labor in such manner as to secure the greatest economic return. In a word, our political economy, which has been unmoral, must be made moral, if it is to be the science

which shall direct men into the proper paths for the production and distribution of wealth" (pp. 773, 774).

If this be true, then even under existing conditions it may be said that "the stars in their courses" fight for righteousness. For it would appear that co-operation, which has been so essential to man's success in the struggle for existence, by cultivating the moral qualities upon which social fitness depends, has at length brought about conditions where moralization becomes a prime factor in the success and survival of society. At all events it can, I think, be maintained that the law of the survival of the fittest admits of another interpretation than that put upon it by Prof. Huxley. It is not of necessity, as he thinks, opposed to the ethical progress of the race, but under it and because of it men become better through the survival of the socially fit.

ROBERT MATHEWS.

ROCHESTER, N. Y., *June 29, 1893.*

THE CREATION.

A PENOBSCOT INDIAN MYTH TOLD BY ONE OF THE TRIBE TO ABBY L. ALGER.

IN the beginning God made Adam out of the earth, but he did not make Glūs-kābé (the Indian God). Glūs-kābé made himself out of the dirt that was kicked up in the creation of Adam. He rose and walked about, but he could not speak until the Lord opened his lips.

God made the earth and the sea, and then he took counsel with Glūs-kābé concerning them. He asked him if it would be better to have the rivers run up on one side of the earth and down on the other, but Glūs-kābé said, "No, they must all run down one way."

Then the Lord asked him about the ocean, whether it would do to have it always lie still. Glūs-kābé told him, "No!" It must rise and fall, or else it would grow thick and stagnant.

"How about fire?" asked the Lord; "can it burn all the time and nobody put it out?"

Glūs-kābé said: "That would not do, for if anybody got burned and fire could not be put out, they would die; but if it could be put out, then the burn would get well."

So he answered all the Lord's questions.

After this Glūs-kābé was out on the ocean one day and the wind blew so hard he could not manage his canoe. He had to go back to land, and he asked his old grandmother (among Indians this title is often only a mark of respect and does not always in-

dicate any blood relationship), Māhli Moninkwess (the woodchuck), what he could do. She told him to follow a certain road up a mountain. There he found an old man sitting on a rock flapping his wings (arms) violently. This was Wūchowsen, the great wind-blower. He begged Glūs-kābé to take him up higher where he would have space to flap his wings still harder. So Glūs-kābé lifted him up and carried him a long way. When they were over a great lake he let Wūchowsen drop into the water. In falling he broke his wings and lay there helpless.

Glūs-kābé went back to sea and found the ocean as smooth as glass. He enjoyed himself greatly for many days, paddling about, but finally the water grew stagnant and thick, and a great smell arose. The fish died and Glūs-kābé could bear it no longer.

Again he consulted his grandmother and she told him that he must set Wūchowsen free. So he once more bore Wūchowsen back to his mountain, first making him promise not to flap his wings so constantly, but only now and then, so that the Indians might go out in their canoes. Upon his consent to do this, Glūs-kābé mended his broken wings, but they were never quite so strong as at first, and thus we do not now have such terrible winds as in the olden days.

This story was told to me by an old man whom I had always thought dull and almost in his dotage; but one day, after I had told him some Indian legends, his whole face changed, he threw back his head, closed his eyes, and without the slightest warning or preliminary began to relate, almost to chant, this myth in a most extraordinary way, which so startled me that I could not at the time take any notes of it, and was obliged to have it repeated later. The account of Wūchowsen was added to show the wisdom of Glūs-kābé's advice in the earlier part of the tale, and is found among many tribes.

STATE INTERFERENCE IN SOCIAL AFFAIRS.*

By JOSEPH SHIELD NICHOLSON, D. Sc.,
PROFESSOR OF POLITICAL ECONOMY IN THE UNIVERSITY OF EDINBURGH.

WE are confronted with the limited power of the state and the infinite variety of individual enterprise. To the older economists the difference seemed so great that they considered the presumption against state interference to be established. The rule, it is true, was never absolute and unqualified. Adam Smith

* From the presidential address before the Section of Economic Science and Statistics of the British Association for the Advancement of Science, at the Nottingham meeting, September, 1893 (London Times Report).

himself indicated some of the most important of these exceptions, and the list has been extended by his successors. But these exceptions were all based upon reasoned principles, such as the incapacity of the persons concerned, e. g., children to make fair contracts; the lack of individual interest in public works, e. g., the maintenance of roads, and the importance of the highest security, as in the regulation of the issues of bank notes. And in spite of all these exceptions—strengthened and purified by these exceptions—the presumption remained undisturbed. Recently, however, some writers, under the influence of the ideal of *maximum* happiness and impressed by the power of the state, have sought to extend its interference far beyond these admitted principles. But, so far as this movement has any theoretical support, the reaction has already begun. The fundamental importance of freedom of contract has become more apparent than ever through the application of the comparative and historical methods to jurisprudence; the proposition that the progress of society has been from *status* to contract has almost acquired the force of an axiom. The analysis, too, of modern industrial systems in which division of labor has become more and more intricate and interdependent has shown the hopelessness of the attempt to transfer the management and control to the state. Changes in the methods of production, in the diffusion of knowledge, and in the transport of material commodities have been so rapid and so great that no executive government could have overtaken them. In the most advanced communities even that legislation which is necessary for the new conditions lags behind; even those elementary forms which simply aim at giving an interpretation to contracts in doubtful cases, or which are necessary for the adjustment of responsibility (as in bankruptcy and partnership), are behind the times. The growth of joint-stock enterprises has outstripped the development of the law of companies, and there is a crop of new frauds without corresponding penalties. Turning to the executive and administrative functions of government, the analysis of existing conditions shows that we have not yet overtaken those exceptions admitted by the strongest supporters of *laisser faire*. The British Government has, it is true, wasted its energies in devising temporary expedients of various kinds, but it has not yet accomplished the programme of Adam Smith. Not only are there privileges and restrictions that ought to have been abolished long ago, but on the positive side the programme is not complete. We have just begun universal education on the lines laid down by Adam Smith, but his scheme for imperial federation is not yet within the range of practical politics. We have effected great financial reforms, but we still fall far short of the full development of his principles. Even in matters of currency

and banking—in relation to which the function of the state has always been recognized—we are lamentably in need of reform. But if the state can not overtake those duties which are so necessary and persistent that they were forced on the attention of the strongest supporters of *laisser faire*, how can we possibly justify the assumption of new functions which rest upon no better principle than the vague idea that the state ought to do something? Not only theoretically but practically signs of a reaction in favor of the old position are rapidly increasing. The experiments already made at playing the *rôle* of omnipotence and omniscience, against which governments were so emphatically warned by Adam Smith, have begun to bring forth thorns instead of figs. A government which lends its power and assistance to one set of people must be prepared to act in a similar manner in all similar cases. If once this principle is abandoned, governmental action becomes either a matter of chance or depends upon clamor and jobbery. It is wonderful how quickly the human mind discovers analogies in grievances, and how soon one cry leads to another. How can we justify the use of state credit for the purchase of lands in Ireland and fishing boats in Scotland if we are not prepared to give similar aid to the poor of England who are similarly situated? If we grant judicial rents in the country, why not in the towns, and if we fix by law one set of prices why not all prices? We must not be content with looking at the immediate effects of legislation; we must consider also the secondary and more remote consequences. The British Government is beginning to find that the camel is getting too far into the tent. The admission of a single ear is nothing to the admission of the hump and the knees and the rest of the beast. Now the ear may be interpreted to mean the grant of a few thousand pounds to Scottish fishers, the hump is universal old-age pensions at a cost of some fifteen or twenty millions a year, and for the knees you may take the nationalization of land at a cost of some two thousand millions, and for the whole beast you have the complete socialist programme. The conclusion that when the beast was in the Arab was out needs no interpretation. We have not yet reached the limits of tolerable taxation, but at the present rate of growth of imperial and local expenditure we are rapidly approaching those limits. It has been firmly established in theory, and confirmed by the experience of many nations, that excessive taxation is ruinous to a country. It may be replied that those who demand a large increase of expenditure for public purposes do not propose to tax the poor, but only to take the superfluities of the rich—to take, as is sometimes said, twenty shillings in the pound from that part of every income which extends above four hundred pounds a year. The certain effect of this kind of taxation would be that in a very

short time nobody would have more than four hundred pounds a year, and the sources of taxation would dry up just as people had become used to and dependent on governmental assistance. [Laughter.] The general argument may be summarized in the favorite phraseology of the day. The utility of every increment of governmental work rapidly diminishes, and the disutility of every increment of taxation rapidly increases. The classical economists maintain that even if the state could do something for individuals as cheaply and effectively as they could do it for themselves, it is in general better to trust to individual effort. The decisive consideration is the effect on the character and energies of the people. Self-reliance, independence, liberty—these were the old watchwords—not state reliance, dependence, and obedience. In the matter of pauperism, for example, they teach us to distinguish between the immediate effects of relief which may be beneficial and the effects of reliance on that relief which may be disastrous. They are bold enough to maintain that the condition of life of the dependent pauper should not be made by aids and allowances better than that of the independent laborer. They insist on the great historical distinction between the sturdy rogues and vagabonds—who can work and will not—and the impotent poor, the poor in very deed, who can not support themselves. They look upon the payment of poor rates as they look upon other forms of taxation—namely, as the lesser of two evils; they do not try to persuade themselves and other people that it is a duty which is essentially pleasant. If Christian charity realized a tithe of its ideal there would be no need for relief on the part of the state. It does not take ten ants to relieve another ant, and in this land of ours there are more than ten professed Christians to every pauper. To the student I would say, political economy has a vast literature, and you will not find all the good concentrated in the last marginal increment; you must master the old before you can appreciate the new; a portion of truth just rediscovered for the hundredth time by some amateur is not of such value as a body of doctrines that have been developed for more than a century by economists of repute. And to the legislator I would say, vaster than the literature of political economy is the economic experience of nations; the lessons to be learned from the multitudinous experiments of the past can never become antiquated, for they have revealed certain broad features of human character that you can no more disregard than the vital functions of the human body. Just as Harvey did not invent but discovered the circulation of the blood, so Adam Smith did not invent but discovered the system of natural liberty. And nothing has been better established than the position that legislation which neglects to take account of the liberties of individuals

is foredoomed to failure. If they can not break through the law they will get behind the law. The first duty of the legislator is to take account of the natural forces with which he must contend, and the classical economists have made a survey and estimate of these forces which, based as it is on the facts of human nature and the experience of nations, it would be willful folly to overlook.

THE FRUIT INDUSTRY IN CALIFORNIA.

By CHARLES HOWARD SHINN.

IT seems to me that an account of the present condition of the fruit industry in California would be of economic value, provided that it were entirely free from the advertising element. By the "advertising element" I mean that very natural and almost irrepressible desire of a resident of any portion of this magnificent country to attract others to his particular district. There ought to be some way of presenting statistical and other facts relating to one department of horticulture in a given American State, in exactly the same spirit that an expert upon cotton manufacture would arrange the statistics of the mills of Massachusetts.

A considerable area of California lands is planted to orchards and vineyards. Some of these, as with other human enterprises, are profitable, and some are unprofitable; but all are producing fruit, most of which finds its way in some shape to markets outside the State. The range of these fruit products is very great, and many American producers, as well as those of Europe and other parts of the world, feel the competition of this food supply. An immense number of consumers, as well as this army of rival producers, must wish to obtain statistics of the California industry under consideration. The following article is an attempt to present the facts of a great fruit-growing industry so plainly that all its departments can be understood by the reader.

First, let us examine the best available statistics of the area planted, and the kinds of fruit used. These are much more complete now than when the officers of the last national census attempted to collect them from county officials, because competent agents of the State Board of Horticulture, themselves fruit-growers, spent the greater part of last year in making a "house-to-house canvass." They asked every man who owned an orchard to write down the number of acres he had in fruit trees, and classified the result, in many cases, by actual inspection of the orchard. The mass of details is of course too ponderous to be printed here, but the results can be analyzed so as to justify presentation in a series of tables. There are several ways of pos-

sible classification, but I can think of nothing better than to take the principal fruit-growing counties, give their areas and the acreage now planted, arranging the fruits reported upon in four divisions—the citrus and semitropic species, the nut-bearing trees, the ordinary deciduous fruits, and lastly the vines and small fruits.

CLUSTER OF UVARIA OLIVES.
(One half natural diameter.)

The principal citrus and semitropic fruits grown in California are the fig, olive, lemon, and orange. The citron of commerce flourishes, but has not been much planted, and the lime does well in some districts. The pomegranate is in many gardens, but few commercial orchards exist, and the same is true of the loquat and guava. Here and there in sheltered, frostless places are the beginnings of some small plantations of pineapples, bananas, and date palms, and a few specimens of cherimoya, granadilla, alligator pear, jujube, melon shrub, chayota, the best species of opuntia, and other tropic and semitropic fruits that are being tested on a very small scale. Easily first, and type of the whole class, is the orange. It is commercially grown to the extent of a hundred acres or more in fifteen counties of California; eight counties contain over five hundred acres apiece. The acreage of the new county of Riverside, created by the last Legislature, is necessarily included in San Bernardino, and that of Kings County in Tulare.

TABLE I.—*Acreage of Semitropic Fruits.*

COUNTY.	Oranges.	Olives.	Lemons.	Figs.
Butte	2,664	755	50	259
Los Angeles	12,297	788	2,000	973
Orange	5,412	270	681	82
San Bernardino	38,237	1,200	2,003	362
San Diego	1,500	1,063	4,790	291
Santa Barbara	540	871	1,276	950
Tulare	604	320	63	182
Ventura	548	613	443	62
Total (8 counties)	61,802	5,880	11,306	3,161

The forty-five remaining counties of the State contain acreages as follows: Oranges, 1,559; olives, 3,394; lemons, 1,090; figs, 2,119.

Adding these totals, we obtain the area of the semitropic orchards of California, according to the latest and most reliable data. There are 64,361 acres of oranges, 9,274 acres of olives, 12,396 acres of lemons, and 5,280 acres of figs. The entire acreage devoted to the semitropic fruits above classified is 91,311. No reasonable allowance for small orchards overlooked would be likely to bring this total to much more than 95,000 acres. Studying the table, we

YOUNG FIG TREE. Tejon Ranch.

observe that the leading orange-growing counties are San Bernardino and Los Angeles; the leading fig county is Los Angeles, with Santa Barbara very close, but both still under the thousand-acre mark; the leading olive counties are San Diego and Santa Barbara, and the leading lemon counties are San Diego and Los Angeles. Placer, Butte, Sacramento, and Yuba are the only counties in the Sacramento Valley and northern Sierra foothills that

have a hundred acres of oranges; Fresno, Stanislaus, and Tulare, in the San Joaquin Valley, have also barely commenced the culture of semitropic fruits. But the industry is more at home in the Coast Range valleys from Santa Barbara south and southeast. There, also, it is of longer growth, three out of four trees being in bearing, while in the counties that have but lately begun to plant semitropic fruits more than half the orchards have not yet fruited to any extent. The beginnings of fig and olive orchards are more generally distributed throughout the State than are lemon and orange orchards. Classified from this standpoint, the lemon is represented by one or more acres in thirty counties, the orange in thirty-eight, the fig in forty-two, and the olive in forty-four.

Deciduous fruits cover a very wide range, both in variety and distribution. The apple, apricot, cherry, peach, prune, and pear are the principal deciduous fruits grown in California. There are some nectarine and quince orchards, and the Japanese persimmon is planted to some extent. Many other deciduous fruit trees find place in family orchards and experimental grounds, but those named comprise all that are of commercial value at the present time.

A complete table of the deciduous fruit acreage by counties would include every one of the fifty-three. The apple, for instance, is grown everywhere. The peach and prune better represent the deciduous fruits. A unit of one hundred acres would force us to classify some forty-five counties. Even five hundred acres as a unit would list twenty-nine counties; but, by raising it to a thousand acres, we include all, or nearly all, of the famous deciduous fruit districts.

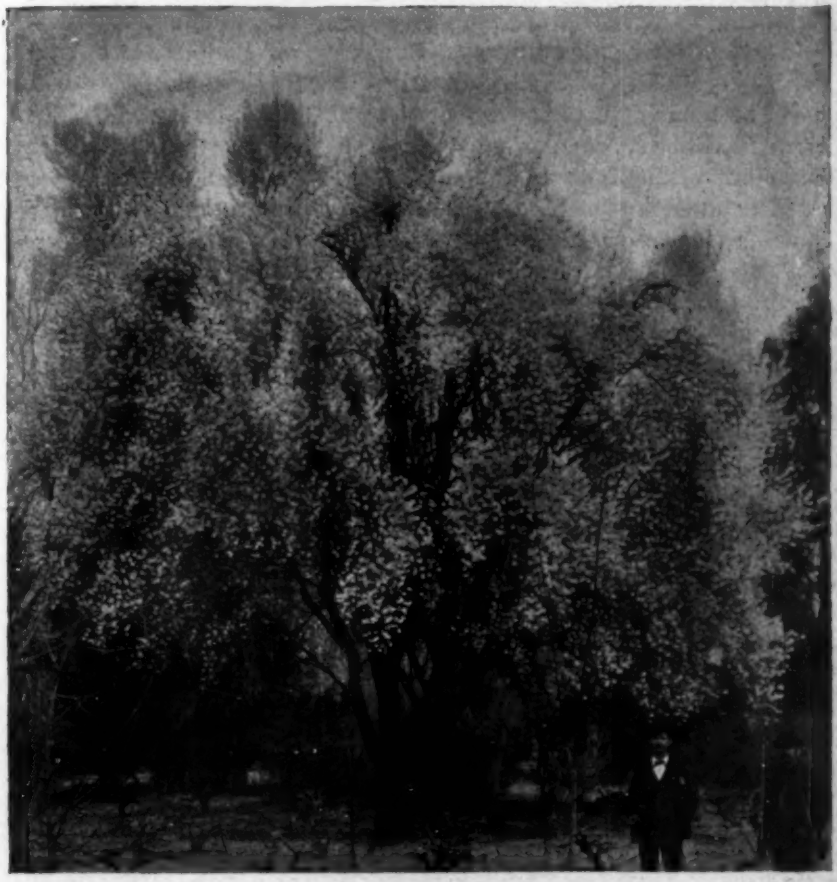
TABLE II.—*Acreage of Deciduous Fruits.*

COUNTY.	Apples.	Apricots.	Cherries.	Peaches.	Pears.	Prunes and plums.
Alameda	505	3,310	2,171	1,375	1,701	4,236
Butte	307	540	165	3,286	913	1,144
El Dorado	225	29	39	1,338	200	279
Fresno	185	556	7	2,058	634	1,601
Kern	338	320	25	1,079	315	946
Los Angeles	1,511	2,899	18	4,059	1,661	3,748
Orange	128	1,492	10	1,203	900	905
Placer	332	280	272	3,621	1,070	615
Sacramento	139	535	160	2,870	2,900	1,770
San Bernardino	222	1,554	15	2,090	402	1,463
Santa Clara	750	4,350	1,250	5,570	900	8,900
Solano	153	3,733	436	4,915	3,050	2,870
Sonoma	4,121	229	317	2,507	1,407	2,600
Tehama	86	574	100	3,182	520	1,328
Tulare	147	724	10	3,800	642	5,270
Yolo	75	824	50	1,040	621	1,522
Total (16 counties)	9,224	21,949	5,045	43,993	17,836	39,197

DRYING THE APRICOTS.

The remaining thirty-seven counties of the State contain acreages as follows: Apples, 10,753; apricots, 8,176; cherries, 1,883; peaches, 11,007; pears, 5,906; prunes and plums, 15,445. Adding these totals, we obtain the area of the deciduous orchards. There are 19,977 acres of apples, 30,125 acres of apricots, 6,928 acres of cherries, 55,000 acres of peaches, 23,742 acres of pears, and 54,642 acres of prunes and plums.

The deciduous fruits lead in acreage and value of products all other branches of California horticulture; and as the above table



ALMOND TREE IN FEBRUARY. Rancho Chico.

plainly shows, the same concentration of each separate variety of fruit in some particular district is manifest everywhere. There are apple counties, peach counties, prune counties, and always will be, although some changes will take place in a decade or two. Peaches, prunes, and apricots occupy nearly three fourths of the acreage. The cherry orchards, although covering the smallest

area, are more profitable, and give employment to more laborers, in proportion to acreage, than any others of the class. The greater part of the apple crop is consumed at home, but all the other fruits must find their chief market outside the State.

In addition to the acreage already tabulated, there are 1,080 acres of nectarines, 300 acres of quinces, and about 100 acres of Japan persimmons. This makes a grand total of 191,894 acres devoted to this class of fruits. Statistics are somewhat incomplete for some of the mountain counties, but it will not be safe to add more than five per cent, and we can then say in round numbers that 200,000 acres are planted with the deciduous fruits.

The leading apple counties of the State are Sonoma, Los Angeles, Siskiyou, Santa Cruz, San Diego, and Humboldt. Nothing could better illustrate the extent to which the climate of California is modified by local conditions. San Diego is the most southern county, Siskiyou is the most northern, and they are separated from each other by more than seven hundred miles, but both contain great apple-growing districts. The leading apricot counties are Solano, Alameda, and Los Angeles. The cherry is chiefly grown in Alameda and Santa Clara. The peach industry has been most completely developed in Santa Clara, Solano, Los Angeles, Tulare, Butte, and Tehama. Nectarines are mostly planted in Sonoma and Alameda. Plums and prunes seem to belong chiefly to Santa Clara, Tulare, Alameda, and Solano. Lastly, the great pear districts are in Sacramento, Solano, Alameda, and Los Angeles. The Coast Range lowlands and foothills, together with a few districts in the San Joaquin and Sacramento Valleys, produce the bulk of all the deciduous fruits.

Third among the horticultural divisions that I have thought it desirable to tabulate are the nut-bearing trees, comparatively small in present acreage, but likely to become more and more important industries. The nuts grown on a commercial scale are only two, the almond and the walnut. The chestnut, pistachio, filbert, pecan, and a few others have been planted to some extent. The following table shows the counties that have 1,000 acres and upward of either almonds or walnuts:

TABLE III.—*Acreage of Nut-bearing Trees.*

COUNTY.	Almonds.	Walnuts.
Alameda	1,237	36
Butte	1,588	12
Los Angeles	107	1,789
Orange	102	2,592
Santa Barbara	340	1,203
Solano	1,470	70
Ventura	150	6,310
Total (7 counties)	4,984	11,022

The remaining forty-nine counties only bring the total of almond trees in the State to 9,400 acres and that of walnuts to 14,912 acres. One can easily see how limited are the districts as yet devoted to these products. Three almond counties—Butte, Solano, and Alameda—contain nearly one half of the total acreage of the State; four walnut counties—Ventura, Orange, Los Angeles, and Santa Barbara—contain more than four fifths of all the trees planted. The almond, however, is grown to some extent in forty-six counties and the walnut in forty-five. Italian chestnuts, pecans, and filberts have been planted to the extent of perhaps 100 acres. This makes the total acreage of nut-bearing trees in the State 24,412. It is not likely that more than 100 or 200 acres were overlooked. In round numbers there may possibly be 25,000 acres in this class of trees.

The last division contains the grapes and small fruits. Wine and raisin grapes have been very carefully tabulated each year, but table grapes with less attention to details, and small fruits not at all until recently. The grape industry is mostly carried on in the fourteen counties represented by the following table:

TABLE IV.—*Acreage of Grapes.*

COUNTY.	Wine grapes.	Raisin grapes.	Table grapes.
Alameda	6,396	194	236
Fresno	5,474	43,928	100
Los Angeles	4,632	671	1,182
Napa	18,177	10	52
Placer	354	500	1,421
Sacramento	3,131	385	2,550
San Bernardino	1,024	2,591	274
San Diego	132	4,455	510
Santa Clara	10,294	200	1,200
Santa Cruz	1,365	103	1,253
Solano	1,928	1,328	1,167
Sonoma	22,351	.....	427
Tulare	70	10,264	100
Yolo	1,575	5,500	1,500
Total (14 counties)	76,903	70,077	11,972

The total acreage of wine grapes is 91,428; that of raisin grapes is 81,773; and that of table grapes is 18,732. Besides, the area devoted to small fruits, as far as can be ascertained, is 5,081 acres. Alameda, Sacramento, and San Joaquin contain over three fifths of the small-fruit area of the State.

Returning to grapes, the results are obtained from the statistics of the State Viticultural Commissioners' Report of 1891, with the figures for a few missing counties filled in from other reliable sources. As in previous tables, the chief centers of each department of the industry are easily recognized. Table grapes are of

especial importance in Sacramento, Yolo, Placer, Santa Cruz, Santa Clara, Solano, and Los Angeles, in which counties more than half the table grapes are found. Two counties of the San Joaquin Valley, Fresno and Tulare, have planted five eighths of the total raisin-grape area of the State. Three wine counties—Sonoma, Napa, and Santa Clara—contain five ninths of the total wine-grape area.

In round numbers, then, the fruit and vine acreage of California in October, 1893, is as follows:

Citrus and semitropic	95,000
Deciduous fruits	200,000
Nut-bearing trees	25,000
Grapes	191,933
Small fruits	5,081
Total	517,014

Having ascertained the total acreage, the approximate number of fruit-bearing plants of the kinds tabulated can be readily found. Orchardists set trees at different distances apart according to the soil and the variety: 12′×12′, 15′×15′, 18′×18′, and 20′×20′ can be found within a mile of each other. Walnuts and other strong growing trees are often set 30′×30′, with cultivated crops planted between for a few years. The above systems of planting give respectively the following number of trees to the acre: 302, 193, 134, 108, and 48. Of course, there are many other planting distances in general use. The ordinary rule of multiplying the acreage by 100 has never seemed to me sufficiently accurate, and I should choose 150 as more nearly representative of the orchards of to-day. Grapevines are planted 4′×6′ in the case of some varieties, and 4′×8′, 6′×6′, and 8′×8′ in ordinary vineyards. These distances give the following numbers of plants to the acre: 1,815, 1,361, 1,210, and 680; about 1,200 is probably a fair average.

Tabulated, with a fair allowance for the acreage planted in the spring of 1893, the sum of the whole matter is as follows:

Number of trees on 320,000 acres	48,000,000
Number of vines, etc., on 200,000 acres	240,000,000
Trees and vines of the plant of 1893 (about)	7,500,000
Total number of plants (about)	295,500,000

The reader must remember that every one of these plants, excepting vines grown from cuttings, has been propagated in a nursery, set out by hand with more or less carefulness, and pruned and cultivated. About sixty per cent of the fruit trees are now in partial or full bearing; in the vineyards the proportion is probably somewhat greater.

HILLSIDE VINES AND TREES. Niles Cañon.

What is the gross yield from these trees? Like wheat, or any other staple crop, the average per acre is very much less than one would expect.

There are often such heavy losses from late frosts, drought, insect pests, and fungoid diseases that only a person of more than ordinary intelligence can successfully manage large orchard interests. The average orchard, like the average farm, just about makes a fair living for an industrious man. That this is true can be easily shown by the following figures, and deductions from them:

Orchard and Vineyard Products in 1891.

Class.	Pounds.
Canned fruit	64,790,120
Dried fruit	66,743,134
Fresh, deciduous	101,097,940
Prunes	10,220,700
Raisins	45,558,370
Citrus fruits	88,194,560
Figs	50,000
Nuts	10,318,060
Total shipment, in pounds	386,972,884

It requires not less than 600,000,000 pounds of fresh fruits, besides the nuts, to produce the above results. In round figures, then, 600,000,000 pounds represent the fruit surplus of the State, in the departments of deciduous fruits, citrus fruits, raisins, and table grapes. In addition there was a surplus of

Wine (gallons)	11,114,029
Brandy (gallons)	799,614
Olive oil (cases)	12,088

Now, there are in California about 500,000 acres of the trees and vines which produce these 600,000,000 pounds of fresh fruit. That is 1,200 pounds to the acre, worth in the orchard from twelve to forty dollars, the average gross value of the crop from an acre of fruit. Of course, many of the trees are not yet in bearing, and some fruit-growers will always have far better returns than this. But the above average is very significant. It shows plainly that the industry can not exist upon a lower average price than one cent a pound for fruit in the orchard. But if the present orchards were in full bearing there might come an especially favorable season which would give a total, even without further planting, of fully 1,500,000,000 pounds. If there are 50,000 acres planted every year, and the old orchards are kept up, the present acreage will be doubled by 1901.

But, to show what has been done under favorable circumstances, I give the following statement of the yield of a 700-acre San Joaquin Valley irrigated orchard in 1890:

Yield of 700-Acre Orchard.

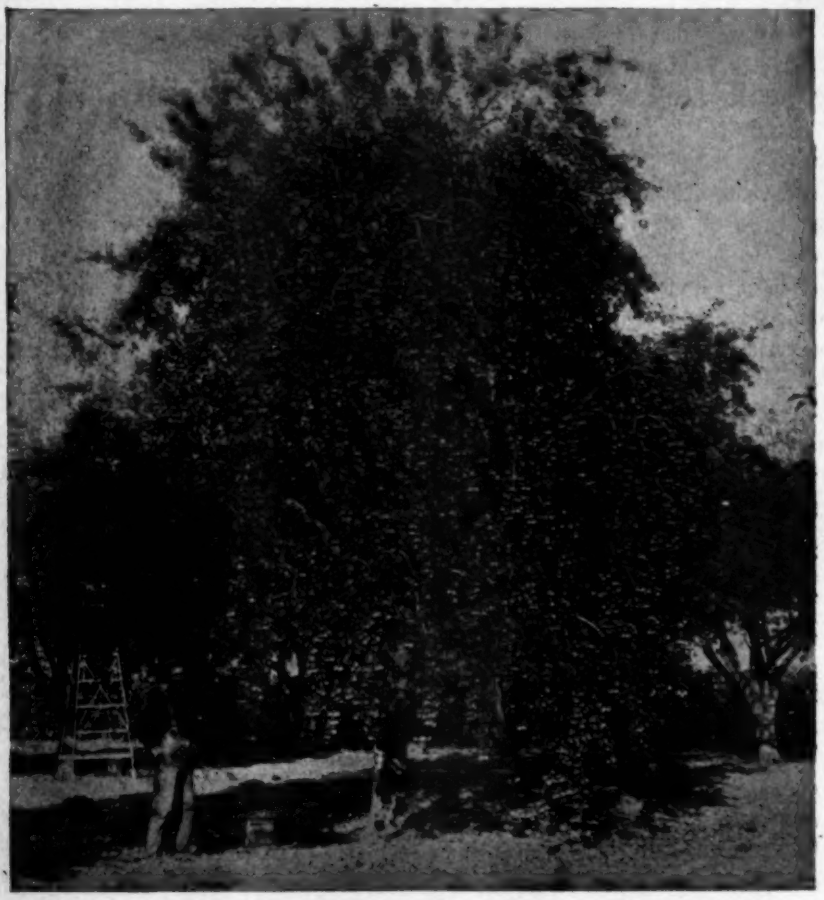
	Pounds.
Apricots	339,411
Peaches	2,115,314
Nectarines	210,518
Pears	280,124
Plums	4,705
Prunes	22,283
Total	2,972,335

This is a well-authenticated yield of nearly 3,000,000 pounds from the orchard, or, to be more exact, within a fraction of 4,246 pounds to the acre. This fruit was sold for $84,365.61, or $120 per acre, gross receipts. The annual product of the 1,200 acres of vines and trees upon this ranch is confidently expected to be 10,000,000 pounds of fresh fruit when every acre comes into bearing, and that is practicable under first-class management. Ignorance or neglect would ruin both orchard and vineyard, however, in less than three years. The average yield per acre, as previously shown, is only 1,200 pounds, but here is a tract of 700 acres, not in full bearing, that gives three and a half times as much. By obtaining the highest possible price, the estimated possible sale of about $45 per acre (when the yield was 1,500 pounds) has been raised in this case to $120 per acre. Should the whole 1,200 acres ultimately yield 10,000,000 pounds, the average per acre will be more than four tons of green fruit, the increase being largely in the item of grapes. Four tons per acre, at a uniform price of one cent a pound, would yield $80, as against the average value of the State crop at that price, $12 per acre.

If the 200,000 acres of deciduous fruits in the State could be made to yield at the rate of this irrigated San Joaquin Valley orchard, the product would now be about 850,000,000 pounds of fresh fruit. The same acreage in full bearing at the expected average would reach the enormous yield of 1,660,000,000 pounds. If the semitropic fruits and vineyards could be depended upon to yield in like proportion, it is safe to say that the fruit supply of the world would be more than provided for, and the transportation facilities of the great railroad lines would be overburdened. But horticulture, like agriculture, is subject to drawbacks and limitations. Orchards and vineyards, exactly the same as corn fields and wheat fields, give only a low general average. The industry of fruit-growing is established upon a solid foundation and is very prosperous, but the whole yield of the State can never be made proportionate to the yield obtained under exceptional circumstances.

The acreage and yield of the orchards and vineyards have now been ascertained. The cash value of the total output can not be

as closely calculated. Floating estimates vary even more than the floating estimates of the acreage. Healthy, well-managed orchards probably average gross sales of $100 per acre, taking all classes of fruit together, and one season with another, but there are no reliable statistics of this side of the industry. Returning to an estimate of a present surplus of 600,000,000 pounds of fresh fruit, this at two cents (the average value in the orchards one year



VACAVILLE PEAR TREE.

with another) would yield the growers $12,000,000 and would probably cost the consumer $36,000,000. This does not include the value of the product of the wine grapes. It only represents the output of the gold mine of the orchards. Commercially, of course, the volume of business created is represented by the cost to the consumer.

Studies of the future of an industry are seldom useful. Planting of trees and vines continues steadily, and if there is a demand

the present output can be indefinitely increased. It is believed by the best horticultural authorities that fruit, in various forms, will become more and more a great food staple, used by the masses of the people, and that new markets for the enormous output can be developed from time to time in the United States and in Europe. Like wheat, a staple, fruit in the future will not make fortunes nor "pay for a ranch in one year," but will give safe, steady returns upon the labor and capital invested.

The extensive area that might be devoted to fruit culture, if the demand justified such a use, can be seen by the following figures: San Bernardino, Riverside, San Diego, and Los Angeles Counties, all noted for their semitropic fruits, contain 26,913,000 acres, or in round numbers one fourth the area of the State. Fresno, Kern, and Tulare, the great irrigated counties of the San Joaquin Valley, famous for their vineyards and deciduous fruit orchards, contain 14,737,000 acres. The rich and beautiful fruit counties of Alameda, Butte, Placer, Sacramento, Santa Clara, Solano, Sonoma, and Ventura, added to the above, bring the total area to nearly 50,000,000 acres. It need not be supposed that all these immense districts can be cultivated. There are deserts and barren mountains, as well as fertile valleys, plains, and hillsides. But if only one third of the area of these counties is capable of being cultivated, and if only one third of the cultivated acreage is used for fruits, these counties alone can produce, when their orchards are in full bearing, twenty times as much fruit as the present entire yield of the State. The future of the fruit industry of California depends upon the growth of the demand for fruit products. All the other conditions are favorable for the development of the business, but the problem of the possible demand can only be solved by continuing to plant trees, gather fruit, and send it to the markets of the world.

The picturesque side of California fruit-growing is very attractive and must long remain so. Just now everything is in the creative stage: vineyards and orchards are being extended along the valleys and up the slopes; the cabins of pioneers are giving place to modern cottages and stately dwellings; villages are fast becoming towns; and towns are rising to the rank of cities. Only about the old missions can one find orchards that deserve to be called venerable, as measured by European standards. Take out a few old trees of olive, fig, orange, and pear, and all that is left are less than forty years old.

Blossoming springtime in these great orchards is charming, as almonds, apricots, peaches, and all the rest of the deciduous fruit trees come into flower over square miles. The very roadsides are sometimes covered with drifts of petals blown from the overhanging boughs. Loquats ripen and are fit to market almost

before the last apple blossoms are gone in the orchards; cherries come next, then the early apricots and plums; the procession goes on month after month, even after the leaves fall. Late apples, pears, and Japanese persimmons mark the California December, mingling as they do with the ripening oranges and lemons and a few figs hanging on the leafless trees.

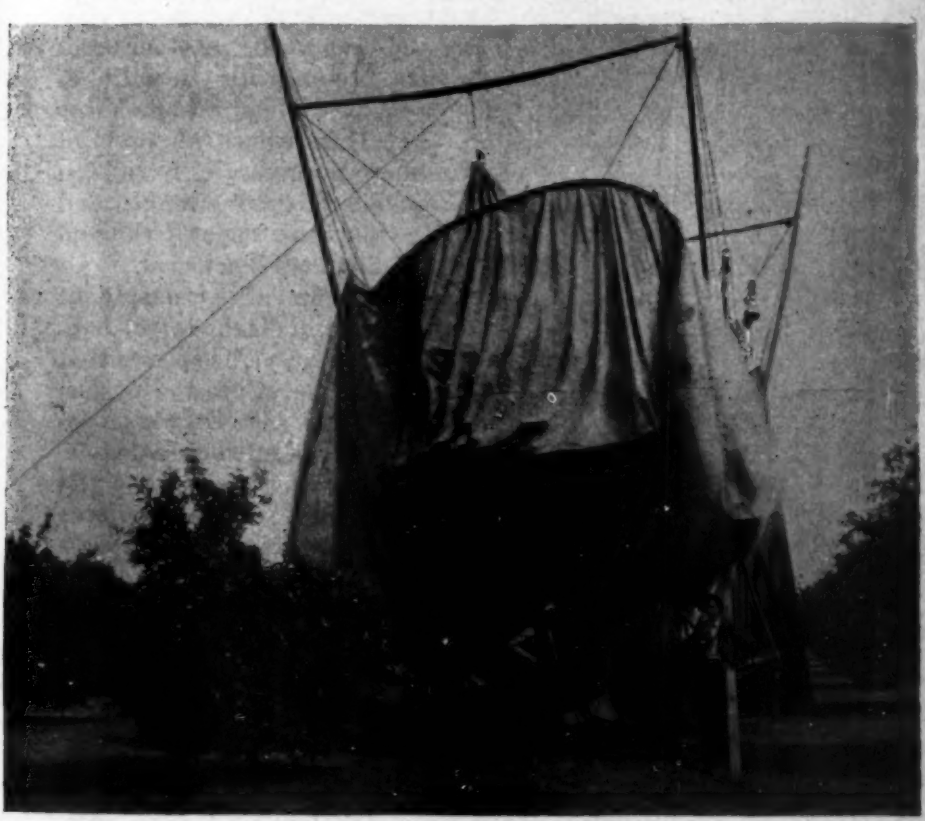
Although the details of the orchard work vary considerably in different parts of California, the more important elements are much the same everywhere. The winter work of pruning is succeeded by the spring work of cultivation and the summer work of harvest. A highly organized system has been developed; labor-saving machinery is used to a great and increasing extent; and the actual cost of producing a pound of fruit can be proved to have lessened every year. One hesitates to say how cheaply fruit can be grown under favorable circumstances by intelligent Americans who know the business. Men are becoming rich at prices that ten years ago would have seemed ruinous. Of course, there is a limit to the process of cheapening production, but the end is still far off. The planting and culture of orchards; the thinning of green fruit; the gathering, handling, packing, shipping, and marketing of ripe fruit; the canning, drying, preserving, and other methods of utilizing fruit products—all these are in a process of continuous evolution.

The foregoing glimpses of the subject indicate more than the beginnings of a great industry. Whoever visits California will see surprisingly vast and imposing results in concrete forms. Valley after valley, town after town live by the toil of the orchardist and vineyardist. The sight is a cheering one, because successful fruit culture requires a high degree of skill and intelligence, a thickly settled rural community, and especial facilities for communication with all that these things imply. The road-improvement societies are little needed in California fruit colonies. Sometimes the macadamized and sprinkled highways extend six or eight miles out of the town to the very edge of the orchards; then, as the wheat fields are reached, they degenerate into very ordinary country roads.

But the educational requirements of this specialized industry extend into new departments of science, and are continually developing so rapidly that only a few trained observers can take note of the advance. Horticulture, applied to the daily needs of such industries as I have described, leaves its servants no time to dream dreams about possibilities of orchard life a century or even a decade hence. Multitudes of perplexing problems of culture and management arise, but two great tasks are always with the educated orchardist or vineyardist. One, briefly stated, is, "Can I produce new and vastly superior varieties by cross-fertili-

zation and scientific study of the laws of heredity and variation applied to plants?" The answer is, "Yes; there is no assignable limit to the capacity of our cultivated fruits, and of fruits still wild, to improve and develop new characteristics."

The second great task relates to the ceaseless struggle with the lower forms of animal and vegetable life which prey upon useful forms in immeasurable and innumerable hosts. Gophers and jack-rabbits are now only pests of minor importance in thickly settled orchard-districts, but the warfare of the horticulturist



FUMIGATING TENT. Hydrocyanic-acid gas process for destroying scale. Chino Valley.

with fungoid diseases and parasitic insects long ago passed its amusing stage. It is a serious business of importance to the whole human race, because whatever threatens the food supply threatens the life of man. The practical applications of skill and capital in the field of preventive and remedial agencies have been remarkable. Every successful Californian fruit-grower has now learned that he must as regularly treat his trees for scale and other inflictions as he must plow his land, thin the fruit, or gather the crop. At the spraying season in the fruit districts

it is literally true that the odor of the various preparations used to destroy insect life is universal for miles and for days at a time. Nine tenths of the discussions in the innumerable local clubs of fruit-growers that are doing so much for the practical advance of the industry in California are discussions upon methods for the destruction of these pests. Sometimes one sees hundreds of acres of orchard, in February, snow-white over every inch of twig, with "salt and lime wash," or other acres are brown with sulphite of soda or oil and alkali. Now and then comes an orchard where the remedies have been used in too great strength, and the buds and tender bark seem blighted and blackened.

ALMOND BOUGH IN JULY.

The prevailing enemy of the orchards is the insect family *Coccidæ*. The species that do most harm are the oyster-shell scale (*Mytilaspis pomorum*), the pernicious scale (*Aspidiotus perniciosus*), the yellow orange scale (*Aspidiotus citrinus*), the red orange scale (*Aonidia aurantii*), and the apricot scale (*Lecanium armeniacum*). The Florida red scale (*Aspidiotus ficus*) and the mining scale (*Chionaspis biclavis*), a very dangerous species from Tahiti, are being quarantined against by the horticultural commissioners. A cargo of 325,000 orange trees infested with the Tahiti species was once destroyed by Mr. Craw, the quarantine officer of the State Board. Another group of scale insects known as "cottony scales" (*Icerya* and *Dactylopius*) are among the worst enemies of the orchardist. Aphides, canker worms, caterpillars, and fungoid diseases are as yet of much less immediate danger to the fruit-growers than the various *Coccidæ* of which I have named only the prominent species.

Many valuable formulas for summer and winter washes, for kerosene emulsions, and other preparations were first used in California. The hydrocyanic-acid-gas method is also a Californian

invention. Derricks and tents are used in this gas treatment, and it solves many difficulties in the way of using washes and the spray system on the citrus fruit trees. The city of Riverside owns several complete sets of the necessary apparatus, and rents at a nominal rate to fruit-growers, who hire operators and furnish the necessary chemicals. Since this is not a technical treatise, however, I must refer students of the perpetual struggle going on in California between the orchardist and his insect enemies to the publications of the Agricultural Department of the State University and of the State Board of Horticulture. Here, in thousands of pages, the story is told in every detail. There is not only an active warfare going on against insect foes, but various predaceous and parasitic insects that destroy dangerous species have been called to the aid of the horticulturist.

In conclusion, one must ask, "How goes the fight?" The statistics of the fruit industry answer this question. The cost of destroying insect pests has become a permanent item of expense, the results of which are increased profits. Care and management of orchards now include preparation of the soil; selection of varieties adapted to the place; planting and culture of the trees; pruning, according to different systems for different species and localities; the use of special fertilizers, and the destruction of noxious insect life. The various coccids that infest the California orchard valleys are only to be found in dangerous numbers upon the orchards of the careless or the ignorant fruit-growers. Their multiplication is readily and safely checked on as large a scale as desired, and at a cost paid many times over by the increased crop. Sometimes, for several seasons and over large districts, the coccids disappear, but they return, and renewed expenditures of time and skill are necessary to conquer them again. The expense lessens, however, and the certainty of success increases, year after year as the fruit-grower becomes a specialist. Does this appear too difficult? It is the same old demand for intellect, inherent in the order of things. Horticulture in every division is a science as well as an art, and it more and more amply rewards the technical skill of the well-equipped specialist.

During the discussion in the British Association on anthropometric measurements, Dr. Garson expressed the opinion that there could be no better system than that adopted in the United States, where an enormous number of observations were made on a uniform plan in many schools. If the American plan could be adopted in Great Britain we should be able to compare children on both sides of the Atlantic, and have full details of the growth of the English race. The different methods of anthropometric observation now adopted rendered the results absolutely useless.

CRIMINAL WOMAN.

By Miss HELEN ZIMMERN.

THE school of criminal anthropologists is making great strides in Italy. New works are continually pouring from the press which record the observations of students of this modern science, all of them striving to establish the data on which to base the phenomena of crime and degeneration. The world-famed name of Prof. Cesare Lombroso constantly appears on new works, which are fresh guides to science. La Donna Delinquente (Criminal Woman) is the title of his latest book, which is a joint work written together with one of his pupils, Prof. G. Ferrero. This book completes his previous admirable study entitled L' Uomo Delinquente (Criminal Man). This new study on abnormal woman is a very important work, which offered much greater difficulties in the way of research and observation than that on man. Indeed, Lombroso writes in his preface: "The chief results of our first investigations were in opposition to the usual premises; even individual and partial observations seemed to clash; so that if one wished to be logical one was obliged to hesitate as to definite conclusions. We were, however, faithful to the maxim that we have always pursued; we followed facts blindly, even when they appeared to contradict each other and seemed taking a false turning. And we were not wrong: in the end the facts which seemed most opposed, fitted into their places like the pieces of a mosaic and formed a uniform and perfect design, although at first it seemed as if we were groping in the dark and that it was difficult to collect them. When at last we reached the desired goal, we tasted the bitter delight of the hunter who seizes his prey after scouring rocks and precipices, and feels the joy of his success redoubled by the losses and fatigues his conquest has cost him."

In this quotation is given truly the keynote to the whole volume. It explains to the reader what difficulties the authors have had to surmount, in order to draw a precise and certain conclusion, and to determine the characteristics of female criminals, just as other similar works written by modern *savants* define those of male offenders. The work is divided into four principal parts: 1. Normal Woman. 2. Female Crime. 3. Pathological and Anthropometrical Anatomy of Female Criminals and Prostitutes. 4. Biology and Psychology of Female Delinquents and Prostitutes. The first part is full of observations on normal women, and is a contrast to the second, which treats of female criminals in all their different changes of organism and mental attitude. In the section devoted to normal women, Lombroso

treats of the women of primitive nations and compares them with those of civilized peoples. The study is minute, subtle, and valuable. Nor does Lombroso hesitate even to make comparisons with female animals. This attitude, which might be called a want of respect, Lombroso explains in his preface, saying: "Those who, writing about women, are not content with the close logic of facts, but continue or rather counterfeit the traditions of the middle ages and use chivalry toward the gentle sex, will think that we have often been wanting in respect to them in our work. But if we have not respected our most cherished preconceived ideas, such as the idea of the '*reo nato*' (born criminal), neither have we been afraid of the apparent contradictions which to ordinary eyes might have seemed deleterious to our work. How could we become followers of a conventional and unscientific untruth, which only acquired shape in order to lose it directly?"

And truly science can not feed on rhetoric, and Lombroso's books are not those of a poet or novelist, but those of a scientific man, who believes in his work and who devotes himself seriously to its exigencies, no matter whither its necessary conclusions land him. In his study on criminal woman he brings before us women in every condition of life; he makes a minute study of their good qualities and of their defects, analyzing both, and only speaking when he can draw conclusions from what he has observed and studied. Hence his work is a powerful contribution to that affirmation of modern theories on crime which are destined to change entirely the theories of penal law which have ruled up to the present time.

The first portion of Lombroso's work is divided into chapters which treat of the females of the zoölogical world; of the anatomy and biology of women; of the senses and mind of women; of their cruelty, pity, and maternity; of their love, ethics, vanity, and intelligence. These chapters are so many monographs and present normal woman from every point of view. She is described as always inferior to man, because her faculties are less developed. Strange to say, according to Lombroso, she has less feeling than man. This seems a direct contradiction of all legends and traditions. And is it not woman, rather than man, who is the most ardent opponent to all useless suffering; is it not women who have been the chief promoters of anti-cruelty societies, no matter if this cruelty be practiced on human beings or on animals? But the contradiction is explained, according to Lombroso, by the greater excitability of women and their lesser inhibition. As soon as the primitive barbarities of sexual selection began to be mitigated, men chose as wives the prettiest and gentlest instead of the strongest women, so paying tribute to beauty and the moral qualities that are associated with it. Thus women were

perfected in gentleness, grace, and pleasing manners, and withdrew from those qualities that required strength and cruelty. Other influences, not least among which is the longer duration of maternity, cause civilized women to become more compassionate; but in every woman there is an undercurrent of cruelty, which appears either when her nature is wicked or when her strongest feelings, such as those of mother or wife, are attacked. Hence Lombroso adduces that woman's attitude with regard to cruelty and pity is a contradictory one, which will by evolution give way in favor of gentleness and mercy. In the second part of his work Lombroso compares the crimes of female animals with the crimes of primitive and savage women; and in the third chapter he gives a brief history of prostitution, which he considers as one of the great factors in the promotion of crime. Under the heading, "Crimes of Primitive Women," the writer discusses adultery, abortion, infanticide, witchcraft, and poisoning, and concludes thus: "In general, women savages, like other women, commit fewer crimes than men, although their nature is rather worse than better; and the crimes for which they are punished are in great part conventional, such as those contained in *tabu* and witchcraft. What corresponds to crime among men is for savage women prostitution."

In the Pathological and Anthropometrical Anatomy of Female Criminals and Prostitutes, which forms the third part of the book, all the measurements which serve to establish those irregularities from which the criminal school draws its conclusions have been taken with the greatest care. According to Lombroso, they are for women the following: Height, the length of the arms when opened, and the length of the limbs are inferior in criminals—weight being, in relation to their stature, greater in prostitutes and assassins than in ordinary women. The hands are longer and more developed in prostitutes, the foot shorter, the fingers less developed than the rest of the hand. The size and circumference of the skull in female thieves, and even more so in prostitutes, are small; *vice versa*, the facial diameter and especially the jaw are more developed than in normal specimens. The hair and iris are apt to be darker in criminals, and up to a certain point in prostitutes, in whom, however, fair and red hair are often lighter or darker than the normal color. White hair, which is rare in ordinary women, is twice as frequent in criminals; *vice versa*, with them baldness is rarer during youth and middle age than among ordinary women, while wrinkles are more frequent only when they are middle-aged. It has been difficult to gather these facts with certainty about prostitutes, who are nearly all painted and made up even when quite young; but from the data Lombroso had to go upon, precocious white hair and baldness

would be a common defect, as it is in those who are born delinquents. Irregularities of countenance are to be met with in a greater degree in female assassins and poisoners than in infanticides. The real criminal type is rarer among female than male delinquents; it is found more frequently among prostitutes, and according to a still more precise study made by Tarnowsky, there are more female murderers than thieves, while prostitutes are the most numerous of all.

"In short," as our author writes, "female criminals have less typical faces, because they are less criminal than men, and women in every degeneration present fewer digressions than men, because women being organically conservative preserve the average type even in their moral aberrations; besides which, beauty being a supreme necessity for them, this overcomes all the attacks made by moral degeneracy. Still, it can not be denied that when wickedness is deep-rooted, then the general rule which stamps crime with a type, conquers every obstacle, at least in civilized races, and this is particularly the case with prostitutes, because the latter *recall the type of primitive woman much more than female criminals.*"

The third part closes with a fine chapter on tattooing in women, the tendency to tattoo being, according to Lombroso, an infallible indication of criminal tendencies.

The fourth and last part of the work is entitled The Biology and Psychology of Female Criminals and Prostitutes. It is divided into twelve chapters that are crowded with the most minute and subtle researches. The first three treat of female criminals and prostitutes in general; the others make a separate study of women born with criminal tendencies and those who have become criminals through incidental causes, such as love; suicides; women born with a natural inclination to prostitution; women who have become prostitutes through circumstances; insane criminals; epileptic and hysterical delinquents. It is this portion of the work that has required the greatest circumspection. It is so easy here to fall into errors in drawing conclusions from such complicated and various data as presented themselves, and the more, because the variety of subjects examined is very large. Lombroso, in making a *résumé* of the second chapter, observes that fatness of the palm of the hand and irregularities in the pupil of the eye are greater in prostitutes than in female criminals, but are never so marked as in male criminals. The reflections in the pupil of the eye in prostitutes are, however, duller than in male criminals, this being accounted for by the direct action of syphilis on the nervous centers.

Few women are born with criminal tendencies, according to Lombroso; but when this is the case, criminality is more intense

and depraved in them than in men. They prove themselves most cruel, and when compared with normal women they are found wanting in every attribute belonging to the latter. For example, among women born with criminal tendencies there is a total want of maternal affection, pity, and love; they are excessively erotic and revengeful, revenge among women naturally criminals being one of the chief motives for crime. By a curious contrast in this class a mawkish sentimentality, which is particularly apparent in their letters, takes the place of real and strong sentiment. For instance, Avelina wrote to her lover thus: "I am jealous of Nature, which seems to madden us by its beauty. Dearest one, don't you think that this beautiful weather is made for lovers and speaks of love?" Again: "How I wish the undertaking which would render us free and happy were over" (the murder of her husband); "I must succeed in it, as paradise is in view. The turning of the path is full of roses." Lombroso concludes thus: "Since these women are morally insane, and are wanting in all noble and deep sentiments, they exchange them for exaggerated sophistications, just as a coward boasts of a chimerical and absurd courage in his discourses."

Women born criminals are intelligent, and make up for their weakness and want of physical power to satisfy their natural depravity by having recourse to cunning in their fight against society. But as a whole the type of the woman born to be a criminal shows a great likeness to the type of men criminals, and in the rare case of complete criminality women surpass men in wickedness. Females who have become delinquents by accident—and the greater number of female criminals belong to this class—may be divided into two categories: the one represented by females born with only slight criminal tendencies, the other containing delinquents who differ very slightly from normal women, and who sometimes are nothing but ordinary women whose condition in life has been such as to develop that fund of immorality which is latent in every woman. Prof. Lombroso determines by indubitable data the much-debated question of the affinity between prostitution and criminality, concluding that the psychological and anatomical identity between criminals and born prostitutes could not be more complete; both being morally insane, by a mathematic axiom they become equal. In drawing his conclusions on women who have become prostitutes through circumstances Lombroso says that mentally these are more abnormal than women who have become criminals by choice, because, according to the theory of his school, prostitution and not criminality is the true degeneration of woman, innate female criminals being rare and monstrous exceptions. He says: "Chastity is the strongest feminine sentiment after maternity; it is a sentiment

toward which the minds of women have worked for so many centuries in order to create and consolidate it: thus, if a woman, who though not wanting in chastity loses it easily, she must be more deeply abnormal than a woman who when exposed to great temptations forgets to respect other people's property. This fact is almost normal; the other being instead most abnormal. This is the reason that women who have become prostitutes by chance present many of the characteristics of those born with a natural tendency to prostitution; while female criminals who are almost normal have little in common with innate criminals, these last being a double exception from many points of view, and a sporadic monstrosity." The last chapters treat of insane, epileptic, and hysterical criminals.

This terrible but most necessary examination of criminal women occupies a large volume of six hundred and fifty pages. What remedy can be found? This is the subject of the second volume, which will soon appear, and in which Lombroso will speak of the different social importance of crime and prostitution, the two different forms of male and female crime. The present volume is largely illustrated by designs which serve as proofs of the data collected. It is most interesting to see the reproduction of the different types of female delinquents. As usual, Lombroso speaks with the true modesty of a scientific man.

"Not one line of this work," he writes, "justifies the many tyrannies of which women have been and are still the victims—from the *tabu*, which forbids them to eat meat or to touch cocoanuts, up to that which prevents them learning or, still worse, carrying on a profession once they have learned it. These are cruel and overbearing practices by whose means we have certainly contributed to maintain and, what is worse, to increase the inferiority of woman, so as to be able to despoil her for our advantage, while hypocritically we were covering the docile victim with praises which we did not believe, and which were a preparation for fresh sacrifices rather than an ornament."

His love for his science he has again and again abundantly proved. It is deeply interesting to read the conclusion he himself draws from his labors—a conclusion that "all who believe in woman and her future can but rejoice in."

Much suggestive work has recently been accomplished in the domain of chemistry, in the attempt to apply the principle of gravitation to account for the interactions of the molecules of the elements. "So far," says Prof. Reynolds, of the University of Dublin, "the fundamental hypothesis of 'Newtonian chemistry' has led to conclusions which are not at variance with the facts of the science, while it gives promise of help in obtaining a solution of the great problem of the nature of chemical action."

ETHICS AND THE STRUGGLE FOR EXISTENCE.

By LESLIE STEPHEN.

IN his deeply interesting Romanes lecture, Prof. Huxley has stated the opinion that the ethical progress of society depends upon our combating the "cosmic process" which we call the struggle for existence. Since, as he adds, we inherit the "cosmic nature" which is the outcome of millions of years of severe training, it follows that the "ethical nature" may count upon having to reckon with a tenacious and powerful enemy as long as the world lasts. This is not a cheerful prospect. It is, as he admits, an audacious proposal to pit the microcosm against the macrocosm. We can not help fearing that the microcosm may get the worst of it. Prof. Huxley has not fully expanded his meaning, and says much to which I could cordially subscribe. But I think that the facts upon which he relies admit or require an interpretation which avoids the awkward conclusion.

Pain and suffering, as Prof. Huxley tells us, are always with us, and even increase in quantity and intensity as evolution advances. The fact has been recognized in remote ages long before theories of evolution had taken their modern form. Pessimism, from the time of the ancient Hindu philosophers to the time of their disciple, Schopenhauer, has been in no want of evidence to support its melancholy conclusions. It would be idle to waste rhetoric in the attempt to recapitulate so familiar a position. Though I am not a pessimist, I can not doubt that there is more plausibility in the doctrine than I could wish. Moreover, it may be granted that any attempt to explain or to justify the existence of evil is undeniably futile. It is not so much that the problem can not be answered as that it can not even be asked in any intelligible sense. To "explain" a fact is to assign its causes—that is, to give the preceding set of facts out of which it arose. However far we might go backward, we should get no nearer to perceiving any reason for the original fact. If we explain the fall of man by Adam's eating the apple we are quite unable to say why the apple should have been created. If we could discover a general theory of pain, showing, say, that it implied certain physiological conditions, we should be no nearer to knowing why those physiological conditions should have been what they are. The existence of pain, in short, is one of the primary data of our problem, not one of the accidents for which we can hope in any intelligible sense to account. To give any "justification" is equally impossible. The book of Job really suggests an impossible, one may almost say a meaningless, problem. We can give an intelligible meaning to a demand for justice when we can suppose that a man has certain

antecedent rights which another man may respect or neglect. But this has no meaning as between the abstraction "Nature" and the concrete facts which are themselves Nature. It is unjust to treat equal claims differently. But it is not "unjust" in any intelligible sense that one being should be a monkey and another a man, any more than that one part of me should be a hand and another a head. The question would only arise if we supposed that the man and the monkey had existed before they were created, and had then possessed claims to equal treatment. The most logical theologians indeed admit that as between creature and creator there can be properly no question of justice. The pot and the potter can not complain of each other. If the writer of Job had been able to show that the virtuous were rewarded and the vicious punished, he would only have transferred the problem to another issue. The judge might be justified but the creator would be condemned. How can it be just to place a being where he is certain to sin and then to damn him for sinning? That is the problem to which no answer can be given; and which already implies a confusion of ideas. We apply the conception of justice in a sphere where it is not applicable, and naturally fail to get any intelligible answer.

The question therefore resolves itself into a different one. We can neither explain nor justify the existence of pain; but of course we can ask whether, as a matter of fact, pain predominates over pleasure, and we can ask whether, as a matter of fact, the "cosmic processes" tend to promote or discourage virtuous conduct. Does the theory of the "struggle for existence" throw any new light upon the general problem? I am quite unable to see, for my own part, that it really makes any difference: evil exists; and the question whether evil predominates over good can only, I should say, be decided by an appeal to experience. One source of evil is the conflict of interests. Every beast preys upon others, and man, according to the old saying, is a wolf to man. All that the Darwinian theory can do is to enable us to trace the consequences of this fact in certain directions, but it neither reveals the fact nor makes it more or less an essential part of the process. It "explains" certain phenomena, in the sense of showing their connection with previous phenomena, but does not show why the phenomena should present themselves at all. If we indulge our minds in purely fanciful constructions, we may regard the actual system as good or bad, just as we choose to imagine for its alternative a better or a worse system. If everybody had been put into a world where there was no pain, or where each man could get all he wanted without interfering with his neighbors, we may fancy that things would have been pleasanter. If the struggle, which we all know to exist, had no effect in promoting the "sur-

vival of the fittest," things—so at least some of us may think—would have been worse. But such fancies have nothing to do with scientific inquiries. We have to take things as they are, and make the best of them.

The common feeling, no doubt, is different. The incessant struggle between different races suggests a painful view of the universe, as Hobbes's natural state of war suggested painful theories as to human nature. War is evidently immoral, we think; and a doctrine which makes the whole process of evolution a process of war must be radically immoral too. The struggle, it is said, demands "ruthless self-assertion," and the hunting down of all competitors; and such phrases certainly have an unpleasant sound. But, in the first place, the use of the epithets implies an anthropomorphism to which we have no right so long as we are dealing with the inferior species. We are then in a region to which moral ideas have no direct application, and where the moral sentiments exist only in germ, if they can properly be said to exist at all. Is it fair to call a wolf "ruthless" because it eats a sheep and fails to consider the transaction from the sheep's point of view? We must surely admit that if the wolf is without mercy he is also without malice. We call an animal ferocious because a man who acted in the same way would be ferocious. But the man is really ferocious because he is really aware of the pain which he inflicts. The wolf, I suppose, has no more recognition of the sheep's feelings than a man has of feelings in the oyster or the potato. For him, they are simply non-existent; and it is just as inappropriate to think of the wolf as cruel as it would be to call the sheep cruel for eating grass. Are we, then, to say that "Nature" is cruel because the arrangement increases the sum of general suffering? That is a problem which I do not feel able to answer; but it is at least obvious that it can not be answered offhand in the affirmative. To the individual sheep it matters nothing whether he is eaten by the wolf or dies of disease or starvation. He has to die anyway, and the particular way is unimportant. The wolf is simply one of the limiting forces upon sheep, and, if he were removed, others would come into play. The sheep, left to himself, would still have a practical illustration of the doctrine of Malthus. If, as evolutionists tell us, the hostility of the wolf tends to improve the breed of sheep, to encourage him to climb better and to sharpen his wits, the sheep may be, on the whole, the better for the wolf: in this sense, at least, thus the sheep of a wolfless region might lead a more wretched existence, and be less capable animals and more subject to disease and starvation than the sheep in a wolf-haunted region. The wolf may, so far, be a blessing in disguise.

This suggests another obvious remark. When we speak of the

struggle for existence, the popular view seems to construe this into the theory that the world is a mere cockpit, in which one race carries on an internecine struggle with the other. If the wolves are turned in with the sheep, the first result will be that all the sheep will become mutton, and the last that there will be one big wolf with all the others inside him. But this is contrary to the essence of the doctrine. Every race depends, we all hold, upon its environment, and the environment includes all the other races. If some, therefore, are in conflict, others are mutually necessary. If the wolf ate all the sheep, and the sheep ate all the grass, the result would be the extirpation of all the sheep and all the wolves, as well as all the grass. The struggle necessarily implies reciprocal dependence in a countless variety of ways. There is not only a conflict, but a system of tacit alliances. One species is necessary to the existence of others, though the multiplication of some implies also the dying out of particular rivals. The conflict implies no cruelty, as I have said, and the alliance no good will. The wolf neither loves the sheep (except as mutton) nor hates him; but he depends upon him as absolutely as if he were aware of the fact. The sheep is one of the wolf's necessaries of life. When we speak of the struggle for existence, we mean, of course, that there is at any given period a certain equilibrium between all the existing species; it changes, though it changes so slowly that the process is imperceptible and difficult to realize even to the scientific imagination. The survival of any species involves the disappearance of rivals no more than the preservation of allies. The struggle, therefore, is so far from internecine that it necessarily involves co-operation. It can not even be said that it necessarily implies suffering. People, indeed, speak as though the extinction of a race involved suffering in the same way as the slaughter of an individual. It is plain that this is not a necessary though it may sometimes be the actual result. A corporation may be suppressed without injury to its members. Every individual will die before long, struggle or no struggle. If the rate of reproduction fails to keep up with the rate of extinction, the species must diminish. But this might happen without any increase of suffering. If the boys in a district discover how to take birds' eggs, they might soon extirpate a species; but it does not follow that the birds would individually suffer. Perhaps they would feel themselves relieved from a disagreeable responsibility. The process by which a species is improved, the dying out of the least fit, implies no more suffering than we know to exist independently of any doctrine as to a struggle. When we use anthropomorphic language, we may speak of "self-assertion." But "self-assertion," minus the anthropomorphism, means self-preservation; and that is merely a way of describing the fact that an

animal or plant which is well adapted to its conditions of life is more likely to live than an animal which is ill adapted. I have some difficulty in imagining how any other arrangement can even be supposed possible. It seems to be almost an identical proposition that the healthiest and strongest will generally live longest; and the conception of a "struggle for existence" only enables us to understand how this results in certain progressive modifications of the species. If we could even for a moment have fancied that there was no pain and disease, and that some beings were not more liable than others to those evils, I might admit that the new doctrine has made the world darker. As it is, it seems to me that it leaves the data just what they were before, and only shows us that they have certain previously unsuspected bearings upon the history of the world.

One other point must be mentioned. Not only are species interdependent as well as partly in competition, but there is an absolute dependence in all the higher species between its different members which may be said to imply a *de facto* altruism, as the dependence upon other species implies a *de facto* co-operation. Every animal, to say nothing else, is absolutely dependent for a considerable part of its existence upon its parents. The young bird or beast could not grow up unless its mother took care of it for a certain period. There is, therefore, no struggle as between mother and progeny, but, on the contrary, the closest possible alliance. Otherwise life would be impossible. The young being defenseless, their parents could exterminate them if they pleased, and by so doing would exterminate the race. This, of course, constantly involves a mutual sacrifice of the mother to her young. She has to go through a whole series of operations, which strain her own strength and endanger her own existence, but which are absolutely essential to the continuance of the race. It may be anthropomorphic to attribute any maternal emotions of the human kind to the animal. The bird, perhaps, sits upon her eggs because they give her an agreeable sensation, or, if you please, from a blind instinct which somehow determines her to the practice. She does not look forward, we may suppose, to bringing up a family, or speculate upon the delights of domestic affection. I only say that as a fact she behaves in a way which is at once injurious to her own chances of survival and absolutely necessary to the survival of the species. The abnormal bird who deserts her nest escapes many dangers; but if all birds were devoid of the instinct, the birds would not survive a generation.

Now, I ask, what is the difference which takes place when the monkey gradually loses his tail and sets up a superior brain? Is it properly to be described as a development or improvement of

the "cosmic process," or as the beginning of a prolonged contest against it?

In the first place, so far as man becomes a reasonable being, capable of foresight and of the adoption of means to ends, he recognizes the necessity of these tacit alliances. He believes it to be his interest not to exterminate everything, but to exterminate those species alone whose existence is incompatible with his own. The wolf eats every sheep that he comes across as long as his appetite lasts. If there are too many wolves, the process is checked by the starvation of the supernumerary eaters. Man can preserve as many sheep as he wants, and may also proportion the numbers of his own species to the possibilities of future supply. Many of the lower species thus become subordinate parts of the social organism—that is to say, of the new equilibrium which has been established. There is so far a reciprocal advantage. The sheep who is preserved with a view to mutton gets the advantage, though he is not kept with a view to his own advantage. Of all arguments for vegetarianism, none is so weak as the argument from humanity. The pig has a stronger interest than any one in the demand for bacon. If all the world were Jewish, there would be no pigs at all. He has to pay for his privileges by an early death; but he makes a good bargain of it. He dies young, and though we can hardly infer the "love of the gods," we must admit that he gets a superior race of beings to attend to his comforts, moved by the strongest possible interest in his health and vigor, and induced by its own needs, perhaps, to make him a little too fat for comfort, but certainly also to see that he has a good sty, and plenty to eat every day of his life. Other races, again, are extirpated as "ruthlessly" as in the merely instinctive struggle for existence. We get rid of wolves and snakes as well as we can, and more systematically than can be done by their animal competitors. The process does not necessarily involve cruelty, and certainly does not involve a diminution of the total of happiness. The struggle for existence means the substitution of a new system of equilibrium, in which one of the old discords has been removed, and the survivors live in greater harmony. If the wolf is extirpated as an internecine enemy, it is that there may be more sheep when sheep have become our allies and the objects of our earthly providence. The result may be, perhaps I might say must be, a state in which, on the whole, there is a greater amount of life supported on the planet: and therefore, as those will think who are not pessimists, a decided gain on the balance. At any rate, the difference so far is that the condition which was in all cases necessary, is now consciously recognized as necessary; and that we deliberately aim at a result which always had to be achieved on penalty of destruction. So far, again, as morality can be estab-

lished on purely prudential grounds, the same holds good of relations between human beings themselves. Men begin to perceive that, even from a purely personal point of view, peace is preferable to war. If war is unhappily still prevalent, it is at least not war in which every clan is fighting with its neighbors, and where conquest means slavery or extirpation. Millions of men are at peace within the limits of a modern state, and can go about their business without cutting each other's throats. When they fight with other nations they do not enslave nor massacre their prisoners. Taking the purely selfish ground, a Hobbes can prove conclusively that everybody has benefited by the social compact which substituted peace and order for the original state of war. Is this, then, a reversal of the old state of things—a combating of a "cosmic process"? I should rather say that it is a development of the tacit alliances, and a modification so far of the direct or internecine conflict. Both were equally implied in the older conditions and both still exist. Some races form alliances, while others are crowded out of existence. Of course, I cease to do some things which I should have done before. I don't attack the first man I meet in the street and take his scalp. The reason is that I don't expect that he will take mine; for, if I did, I fear that even as a civilized being, I should try to anticipate his intentions. This merely means that we have both come to see that we have a common interest in keeping the peace. And this, again, merely means that the alliance which was always an absolutely necessary condition of the survival of the species has now been extended through a wider area. The species could not have got on at all if there had not been so much alliance as is necessary for its reproduction and for the preservation of its young for some years of helplessness. The change is simply that the small circle which included only the primitive family or class has extended, so that we can meet members of the same race on terms which were previously confined to the minuter group. We have still to exterminate and still to preserve. The mode of employing our energies has changed, but not the essential nature.

Morality proper, however, has so far not emerged. It begins when sympathy begins; when we really desire the happiness of others; or, as Kant says, when we treat other men as an end and not simply as a means. Undoubtedly this involves a new principle no less than the essential principle of all true morality. Still I have to ask whether it implies a combating or a continuation of a cosmic process. Now, as I have observed, even the animal mother shows what I have called a *de facto* altruism. She has instincts which, though dangerous to the individual, are essential for the race. The human mother sacrifices herself with a consciousness of the results to herself, and her personal fears are overcome by

the strength of her affections. She will endure a painful death to save her children from suffering. The animal sacrifices herself, but without consciousness and therefore without moral worth. This is merely the most striking exemplification of the general process of the development of morality. Conduct is first regarded purely with a view to the effects upon the agent, and is therefore enforced by extrinsic penalties, by consequences, that is, supposed to be attached to it by the will of some ruler, natural or supernatural. The instinct which comes to regard such conduct as bad in itself, which implies a dislike of giving pain to others, not merely a dislike to the gallows, grows up under such protection, and in the really moralized being acquires a strength which makes the external penalty superfluous. This, indubitably, is the greatest of all changes, the critical fact which decides whether we are to regard conduct simply as useful or also to regard it as moral in the strictest sense. But I should still call it a development and not a reversal of the previous process. The conduct which we call virtuous is the same conduct externally which we before regarded as useful. The difference is that the simple fact of its utility—that is, of its utility to others and to the race in general—has now become the sufficient motive for the action as well as the implicit cause of the action. In the earlier stages, when no true sympathy existed, men and animals were still forced to act in a certain way because it was beneficial to others. They now act in that way because they perceive it to be beneficial to others. The whole history of moral evolution seems to imply this. We may go back to a period at which the moral law is identified with the general customs of the race; at which there is no perception of any clear distinction between that which is moral and that which is simply customary; between that which is imposed by a law in the strict sense and that which is dictated by general moral principles. In such a state of things, the motives for obedience partake of the nature of "blind instincts." No definite reason for them is present to the mind of the agent, and it does not occur to him even to demand a reason. "Our father did so and we do so" is the sole and sufficient explanation of their conduct. Thus instinct again may be traced back by evolutionists to the earliest period at which the instincts implied in the relations between the sexes, or between parents and offspring, existed. They were the germ from which has sprung all morality such as we now recognize.

Morality, then, implies the development of certain instincts which are essential to the race, but which may in an indefinite number of cases be injurious to the individual. The particular mother is killed because she obeys her natural instincts; but if it were not for mothers and their instincts, the race would come to

an end. Prof. Huxley speaks of the "fanatical individualism" of our time as failing to construct morality from the analogy of the cosmic process. An individualism which regards the cosmic process as equivalent simply to an internecine struggle of each against all must certainly fail to construct a satisfactory morality, and I will add that any individualism which fails to recognize fully the social factor, which regards society as an aggregate instead of an organism, will, in my opinion, find itself in difficulties. But I also submit that the development of the instincts which directly correspond to the needs of the race, is merely another case in which we aim consciously at an end which was before an unintentional result of our actions. Every race, above the lowest, has instincts which are only intelligible by the requirements of the race; and has both to compete with some and to form alliances with others of its fellow-occupants of the planet. Both in the unmoralized condition and in that in which morality has become most developed, these instincts have the common characteristics that they may be regarded as conditions of the power of the race to maintain its position in the world, and so, speaking roughly, to preserve or increase its own vitality.

I will not pause to insist upon this so far as regards many qualities which are certainly moral, though they may be said to refer primarily to the individual. That chastity and temperance, truthfulness and energy, are, on the whole, advantages both to the individual and to the race, does not, I fancy, require elaborate proof; nor need I argue at length that the races in which they are common will therefore have inevitable advantages in the struggle for existence. Of all qualities which enable a race to hold its own, none is more important than the power of organizing ecclesiastically, politically, and socially, and that power implies the prevalence of justice, and the existence of mutual confidence, and therefore of all the social virtues. The difficulty seems to be felt in regard to those purely altruistic impulses which, at first glance at any rate, make it apparently our duty to preserve those who would otherwise be unfit to live. Virtue, says Prof. Huxley, is directed "not so much to the survival of the fittest," as to the "fitting of as many as possible to survive." I do not dispute the statement, I think it true in a sense; but I have a difficulty as to its application.

Morality, it is obvious, must be limited by the conditions in which we are placed. What is impossible is not a duty. One condition plainly is that the planet is limited. There is only room for a certain number of living beings. It is one consequence that we do in fact go on suppressing the unfit, and can not help going on suppressing them. Is it desirable that it should be otherwise? Should we wish, for example, that America could

still be a hunting ground for savages? Is it better that a country should contain a million red men or twenty millions of civilized whites? Undoubtedly the moralist will say with truth that the methods of extirpation adopted by Spaniards and Englishmen were detestable. I need not say that I agree with him and hope that such methods may be abolished wherever any remnant of them exists. But I say so partly just because I believe in the struggle for existence. This process underlies morality, and operates whether we are moral or not. The most civilized race—that which has the greatest knowledge, skill, power of organization—will, I hold, have an inevitable advantage in the struggle, even if it does not use the brutal means which are superfluous as well as cruel. All the natives who lived in America a hundred years ago would be dead now in any case, even if they had invariably been treated with the greatest humanity, fairness, and consideration. Had they been unable to suit themselves to new conditions of life, they would have suffered a euthanasia instead of a partial extirpation; and had they suited themselves they would either have been absorbed or become a useful part of the population. To abolish the old brutal method is not to abolish the struggle for existence, but to make the result depend upon a higher order of qualities than those of the mere piratical viking.

Mr. Pearson has been telling us in his most interesting book that the negro may not improbably hold his own in Africa. I can not say that I regard this as an unmixed evil. Why should there not be parts of the world in which races of inferior intelligence or energy should hold their own? I am not so anxious to see the whole earth covered by an indefinite multiplication of the cockney type. But I only quote the suggestion for another reason. Till recent years the struggle for existence was carried on as between Europeans and negroes by simple violence and brutality. The slave trade and its consequences have condemned the whole continent to barbarism. That undoubtedly was part of the struggle for existence. But if Mr. Pearson's guess should be verified, the results have been so far futile as well as disastrous. The negro has been degraded, and yet, after all our brutality, we can not take his place. Therefore, besides the enormous evils to slave-trading countries themselves, the lowering of their moral tone, the substitution of piracy for legitimate commerce, and the degradation of the countries which bought the slaves, the superior race has not even been able to suppress the inferior. But the abolition of this monstrous evil does not involve the abolition but the humanization of the struggle. The white man, however merciful he becomes, may gradually extend over such parts of the country as are suitable to him, and the black man will hold the rest, and acquire such arts and civilization as he is capable of

appropriating. The absence of cruelty would not alter the fact that the fittest race would extend; but it may insure that whatever is good in the negro may have a chance of development in his own sphere, and that success in the struggle will be decided by more valuable qualities.

Without venturing further into a rather speculative region, I need only indicate the bearing of such considerations upon problems nearer home. It is often complained that the tendency of modern civilization is to preserve the weakly, and therefore to lower the vitality of the race. This seems to involve inadmissible assumptions. In the first place, the process by which the weaker are preserved consists in suppressing various conditions unfavorable to human life in general. Sanitary legislation, for example, aims at destroying the causes of many of the diseases from which our forefathers suffered. If we can suppress the smallpox, we of course save many weakly children, who would have died had they been attacked. But we also remove one of the causes which weakened the constitutions of many of the survivors. I do not know by what right we can say that such legislation, or again the legislation which prevents the excessive labor of children, does more harm by preserving the weak than it does good by preventing the weakening of the strong. But one thing is at any rate clear. To preserve life is to increase the population, and therefore to increase the competition, and, in other words, to intensify the struggle for existence. The process is as broad as it is long. If we could insure that every child born should grow up to maturity, the result would be to double the severity of the competition for support. What we should have to show, therefore, in order to justfy the inference of a deterioration due to this process, would be, not that it simply increased the number of the candidates for living, but that it gave to feebler candidates a differential advantage; that they are now more fitted than they were before for ousting their superior neighbors from the chances of support. But I can see no reason for supposing such a consequence to be probable or even possible. The struggle for existence, as I have suggested, rests upon the unalterable facts that the world is limited and the population elastic, and under all conceivable circumstances we shall still have in some way or other to proportion our numbers to our supplies, and under all circumstances those who are fittest by reason of intellectual or moral or physical qualities will have the best chance of occupying good places, and leaving descendants to supply the next generation. It is surely not less true that in the civilized as much as in the most barbarous race, the healthiest are the most likely to live, and the most likely to be ancestors. If so, the struggle will still be carried on upon the same principles, though certainly in a different shape.

It is true that this suggests one of the most difficult questions of the time. It is suggested, for example, that in some respects the "highest" specimens of the race are not the healthiest or the fittest. Genius, according to some people, is a variety of disease, and intellectual power is won by a diminution of reproductive power. A lower race, again, if we measure "high" and "low" by intellectual capacity, may oust a higher race, because it can support itself more cheaply, or, in other words, because it is more efficient for industrial purposes. Without presuming to pronounce upon such questions, I will simply ask whether this does not interpret Prof. Huxley's remark about that "cosmic nature" which, he says, is still so strong, and which is likely to be strong so long as men require stomachs. The fact is simply that we have not to suppress it, but to adapt it to new circumstances. We are engaged in working out a gigantic problem: What is the best, in the sense of the most efficient, type of human being? What is the best combination of brains and stomach? We turn out saints who are "too good to live," and philosophers who have run too rapidly to brains. They do not answer in practice, because they are instruments too delicate for the rough work of daily life. They may give a foretaste of qualities which will be some day possible for the average man; of intellectual and moral qualities which, though now exceptional, may become commonplace. But the best stock for the race are those in whom we have been lucky enough to strike out the happy combination in which greater intellectual power is gained without the loss of physical vigor. Such men, it is probable, will not deviate so widely from the average type. The reconciliation of the two conditions can only be effected by a very gradual process of slowly edging onward in the right direction. Meanwhile the theory of a struggle for existence justifies us, instead of condemning us, for preserving the delicate child, who may turn out to be a Newton or a Keats, because he will leave to us the advantage of his discoveries or his poems, while his physical feebleness assures us that he will not propagate his race.

This may lead to a final question: Does the morality of a race strengthen or weaken it; fit it to hold its own in the general equilibrium, or make its extirpation by lower races more probable? I do not suppose that anybody would deny what I have already suggested, that the more moral the race, the more harmonious and the better organized, the better it is fitted for holding its own. But if this be admitted, we must also admit that the change is not that it has ceased to struggle, but that it struggles by different means. It holds its own, not merely by brute force, but by justice, humanity, and intelligence, while, it may be added, the possession of such qualities does not weaken the brute force,

where such a quality is still required. The most civilized races are, of course, also the most formidable in war. But, if we take the opposite alternative, I must ask how any quality which really weakens the vitality of the race can properly be called moral? I should entirely repudiate any rule of conduct which could be shown to have such a tendency. This, indeed, indicates what seems to me to be the chief difficulty with most people. Charity, you say, is a virtue; charity increases beggary, and so far tends to produce a feebler population; therefore, a moral quality clearly tends to diminish the vigor of a nation. The answer is, of course, obvious, and I am confident that Prof. Huxley would so far agree with me. It is that all charity which fosters a degraded class is therefore immoral. The "fanatical individualism" of to-day has its weaknesses; but in this matter it seems to me that we see the weakness of the not less fanatical "collectivism."

The question, in fact, how far any of the socialistic or religious schemes of to-day are right or wrong, depends upon our answer to the question how far they tend to produce a vigorous or an enervated population. If I am asked to subscribe to General Booth's scheme, I inquire first whether the scheme is likely to increase or diminish the number of helpless hangers-on upon the efficient part of society. Will the whole nation consist in larger proportions of active and responsible workers, or of people who are simply burdens upon the real workers? The answer decides not only the question whether it is expedient, but also the question whether it is right or wrong, to support the proposed scheme. Every charitable action is so far a good action that it implies sympathy for suffering; but if it implies such want of prudence that it increases the evil which it means to remedy, it becomes for that reason a bad action. To develop sympathy without developing foresight is just one of the one-sided developments which fail to constitute a real advance in morality, though I will not deny that it may incidentally lead to an advance.

I hold, then, that the "struggle for existence" belongs to an underlying order of facts to which moral epithets can not be properly applied. It denotes a condition of which the moralist has to take account, and to which morality has to be adapted, but which, just because it is a "cosmic process," can not be altered, however much we may alter the conduct which it dictates. Under all conceivable circumstances, the race has to adapt itself to the environment, and that necessarily implies a conflict as well as an alliance. The preservation of the fittest, which is surely a good thing, is merely another aspect of the dying out of the unfit, which is hardly a bad thing. The feast which Nature spreads before us, according to Malthus's metaphor, is only sufficient for a limited number of guests, and the one question is how to select

them. The use of morality is to humanize the struggle; to minimize the suffering of those who lose the game; and to offer the prizes to the qualities which are advantageous to all rather than to those which serve to intensify the bitterness of the conflict. This implies the growth of foresight, which is an extension of the earlier instinct, and enables men to adapt themselves to the future, and to learn from the past, as well as to act upon the immediate impulse of present events. It implies still more the development of the sympathy which makes every man feel for the sufferings of all, and which, as social organization becomes closer, and the dependence of each constituent atom upon the whole organization is more vividly realized, extends the range of a man's interests beyond his own private needs. In that sense, again, it must stimulate "collectivism" at the expense of a crude individualism, and condemns the doctrine which, as Prof. Huxley puts it, would forbid us to restrain the member of a community from doing his best to destroy it. If it be right to restrain such conduct, it is right to carry on the conflict against all anti-social agents or tendencies. I should certainly hold any form of collectivism to be immoral which denied the essential doctrine of the abused individualist, the necessity, that is, for individual responsibility. We have surely to suppress the murderer as our ancestors suppressed the wolf. We have to suppress both the external enemies, the noxious animals whose existence is incompatible with our own, and the internal enemies which are injurious elements in the society itself. That is, we have to work for the same end of eliminating the least fit. Our methods are changed; we desire to suppress poverty, not to extirpate the poor man. We give inferior races a chance of taking whatever place they are fit for, and try to supplant them with the least possible severity if they are unfit for any place. But the suppression of poverty supposes not the confiscation of wealth, which would hardly suppress poverty in the long run, nor even the adoption of a system of living which would make it easier for the idle and the good-for-nothing to survive. The progress of civilization depends, I should say, on the extension of the sense of duty which each man owes to society at large. That involves a constitution of society which, although we abandon the old methods of hanging, and flogging, and shooting down—methods which corrupted the inflicters of punishment by diminishing their own sense of responsibility—may give an advantage to the prudent and industrious and make it more probable that they will be the ancestors of the next generation. A system which should equalize the advantages of the energetic and the helpless would begin by demoralizing, and would very soon lead to an unprecedented intensification of the struggle for existence. The probable result of a

ruthless socialism would be the adoption of very severe means for suppressing those who did not contribute their share of work. But in any case, as it seems, we never get away or break away from the inevitable fact. If individual ends could be suppressed, if every man worked for the good of society as energetically as for his own, we should still feel the absolute necessity of proportioning the whole body to the whole supplies obtainable from the planet, and to preserve the equilibrium of mankind relatively to the rest of Nature. That day is probably distant, but even upon that hypothesis the struggle for existence would still be with us, and there would be the same necessity for preserving the fittest and suppressing, as gently as might be, those who were unfit.—*Contemporary Review.*

THE CALUMET IN THE CHAMPLAIN VALLEY.

By Prof. G. H. PERKINS.

OF the many interesting objects which have been found in different localities in the United States none more fully illustrate the artistic skill and taste of the aborigines than do the stone pipes, and it is probably true that they represent the finest work in stone which the Indian was able to execute. In form, though not perhaps in material, the pipes exhibit greater variety and less conformity to conventional types than do other classes of prehistoric objects. No other specimens in our archæological collections recall so completely the ceremonial usages of the Indians as do the pipes; no other objects occupied so important a place among the possessions of the tribe or the individual, as the student of Indian customs soon learns.

Fig. 1.

Pipes there may have been, and undoubtedly were, many of them of common mold, which were used and regarded very much as are modern pipes, simply as a means of social or personal enjoyment, and these may have been of earthenware, or even of wood or bone, more often than of stone; but the real calumet, the elaborately wrought ceremonial pipe, was a very different affair. With this were associated in the Indian mind the most solemn ceremonies, the most impressive experiences of life. Without the calumet no treaty could be ratified, no war declared, no important tribal or religious question settled. This single object combined in itself a dignity and an essential significance which can hardly be overestimated.

It is not strange, therefore, that the pipemaker should have

exercised his best skill and his most patient labor upon that which he wrought. As Dr. Abbott, in Primitive Industry, well says, "To know the whole history of tobacco, and the custom of smoking and of the origin of the pipe, would be to solve many of the most interesting problems of American ethnology."

The beauty and variety of the pipes which have been found in the Mississippi Valley are unequaled in specimens from any

FIG. 2.

FIG. 3.

other part of the country, and because of this, and because these pipes are so well known, the simpler forms of less favored localities have sometimes been too much overlooked. But the less elaborate New England specimens are not without importance because they have a place in the archæology of the whole country.

In beauty of material and in finish the pipes of the Champlain Valley are quite equal to the best of the mound pipes, but in elaborateness of form they are much inferior. So far as our ancient pipe-makers attempted the execution of any particular form, they usually did very well—that is, unless they destroyed all their failures; but they do not appear to have tried to fashion any very difficult shapes, and very seldom attempted to imitate those animals which were common about them as did the Western tribes. Inasmuch as no two of our pipes are the same in size or form, there is no single type which represents this region.

It is probable that the pipes which have been found in the Champlain Valley were used and, unless obtained in trade or war, made by Algonkins or Iroquois, for these tribes occupied the region from no one knows how early times. Pipes, whether of stone or earthenware, are very uncommon in the Champlain Valley, though diligent search has brought to light a considerable number. In the descriptions and illustrations which are here presented it is the intention of the writer to give a tolerably com-

plete account of such specimens of the class under consideration as have been obtained up to the present time. All the specimens figured are in the collection of the University of Vermont, and all, except Fig. 11, are given of full size.

Our simplest pipes—and it is difficult to imagine a simpler form—are represented by Fig. 1. This is merely a rounded bit of steatite of a grayish color, fairly well shaped and smoothly finished. The excavation is of the same general form as the outside and is very well done. At the top it is rather more than half an inch across. As the figure shows, the opening for the stem is a little below the middle of one side. It is about a fourth of an inch in diameter on the outside, and slopes upward, so that the bowl hung obliquely on the stem. Such a pipe as this must have had some sort of a stem, either a bit of hollow reed, a twig with the pith removed, or the wing bone of a bird.

In Fig. 2 we see a somewhat more elaborate specimen, though the material is very much the same. As the line showing the excavation indicates, the stem, if there was one, entered at the bottom. It is also noticeable that the inside does not at all cor-

FIG. 4.

FIG. 5.

respond with the outside, but is more regular. About the upper margin there is a rather weak attempt at decoration in rudely incised lines around the bowl and oblique lines between. This pipe is well polished. It is two inches and a quarter long and seven eighths of an inch in diameter at the top.

No other specimen from this region is in any respect like that shown in Fig. 3. As may be readily seen in the figure, there are two bowls of nearly equal size. The separation of the bowls is,

however, more apparent on the outside than it is inside, since the partition is largely cut away, the two cavities being distinct only at the top and a short distance below it. Most unfortunately, the lower end is broken, so that it is not possible to know exactly how it terminated. Probably, however, this part of the pipe grew narrower and formed a stem or mouthpiece. As is true of most of our pipes, the excavated portion was cut, not bored, for the numerous tool-marks are parallel with the long axis of the bowl; moreover, the openings are not quite circular, as they must have been if the bowl had been drilled out. The opening at the top of each is nearly five eighths of an inch in greatest diameter. The height is about two inches. At *a* is the small opening into the double bowl. The specimen is very well polished. The material is a fine-grained, dark-green steatite. It was found near Swanton, in the northern part of Vermont, as also were those previously described.

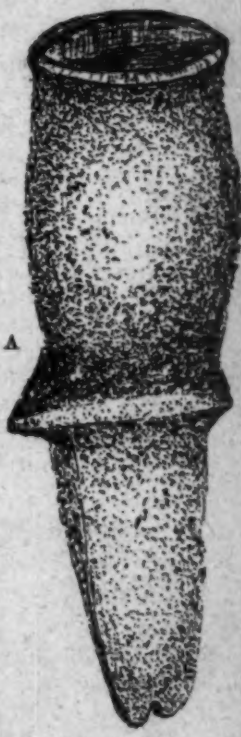


FIG. 6.

Another very unique specimen is seen in Fig. 4. It is apparently intended to represent some quadruped, and if so it is especially interesting, as the only object thus far discovered in this region having the form of an animal. Although a rather clumsy piece of work, I think that there can be no doubt that the maker tried to fashion the pipe after a bear or some other familiar animal. The four legs are well defined, and those on the one side are separated from those on the other by a deep groove. The material is the usual steatite, of a gray color, and the surface is smooth and fairly well polished. As the figure shows, there are about the bowl several oval or quadrangular excavations, which may have been considered sufficiently ornamental in themselves, or they may have been filled by some ornamental bits of stone or shell. As compared with the entire pipe, the hollow of the bowl is small and not much larger than the opening for the stem. The length of this pipe is over two inches and the width is one inch, while the height is a little more.

In an article by the writer in The American Naturalist,* a Vermont pipe is mentioned and figured which has a projection on one side of the rim that may very probably have been intended

* Vol. xiii, p. 735.

for the beak of a bird, and if this is true we have two animal carvings, such as they are, from this region.

In some respects the most interesting of all our pipes is that shown in Fig. 5. Its form is quite peculiar, but the chief importance consists in the carved human faces, one on each side of the top, one of which the figure shows. As may be seen at the base, the pipe is oval in section, the transverse diameter being an inch and a half. The cavity is unusually large and is about three fourths of an inch deep. The stem opening is seen on one side of the figure near the middle, and is about as large as an ordinary pencil. The whole height is over two inches. The faces are in rather bold relief, and of the form seen in the figure; the face on the side not shown is very nearly like that shown. As the figure shows, there are two lines, one from each side of the nose. Do these indicate streaks of paint, or are they intended to represent a mustache and therefore a European face? At the base, which is flat, there is, just below the place where the stem entered, a small hole, as if to enable the owner to attach a thong for suspending the pipe when not in use. The material is very dark steatite. The specimen was found on Grand Isle in Lake Champlain. Only one other specimen having upon it the carving of a face has been found in the Champlain Valley; this is a pipe of oval

FIG. 7.

section and in general a bag or pouch-like form, bearing in full relief on the edge of the bowl a small but distinctly marked head. Singularly, this face also has lines under the nose, which may, as in the pipe figured, indicate by the mustache a European.

A very regularly shaped and beautifully polished specimen is that shown in Fig. 6. It is three and a half inches long and an inch in diameter at the top. The opening for the stem is at the point marked A, and this is at the bottom of the bowl, the

portion below this being solid. The bowl is polished inside, and ornamented about the top by a series of transverse lines.

The well-known platform pipes of the West and many other localities are not common here, but now and then a specimen is

FIG. 8.

found. Fig. 7 gives one of the best of these. It is of a very pretty, light yellow stone, well polished. The opening through which to draw the smoke is at A, and this is so small that it is most probable that no other stem than that afforded by the base itself was used. The platform is nearly three inches long, and the bowl is an inch and a quarter high. The bowl of this pipe differs from that of most of those found here in that it bears circular striæ, and was evidently worked out with a drill.

Pipes of a more modern form than those described, though there is no reason to consider them as actually more recent, are not uncommon among our specimens. The finest example of this class is that shown in Fig. 8, and it is very elegantly finished. The material is a dark, clouded gypsum, hard enough to take an excellent polish. The outside of the bowl was ornamented, like that of Fig. 4, by inlaid pieces of stone, the excavations for which are evident in the figure. There can be no doubt in this case that the cavities were intended not for ornament, but to receive some different material, since they are left in an unfinished state, while the rest of the pipe is unusually well finished. The bowl is pol-

FIG. 9.

ished inside near the top, but lower, circular striæ are to be seen. The stem is rather thick; the upper surface is made up of two sloping planes, and there is a narrow groove running from the bowl to the end. Measured on the outside, the bowl is two inches high; the stem is about a fourth of an inch longer. Several quite similar pipes have been found on both sides of the lake. A simpler though well-made pipe is that given in Fig. 9. It is not so perfectly polished as the preceding, and is one of the more common sort.

It is well known that no material was so highly valued for making pipes as the famous red pipestone. If the calumet had any ceremonial significance in itself, as it certainly had, this became doubly great if the pipe were made of the red stone. This

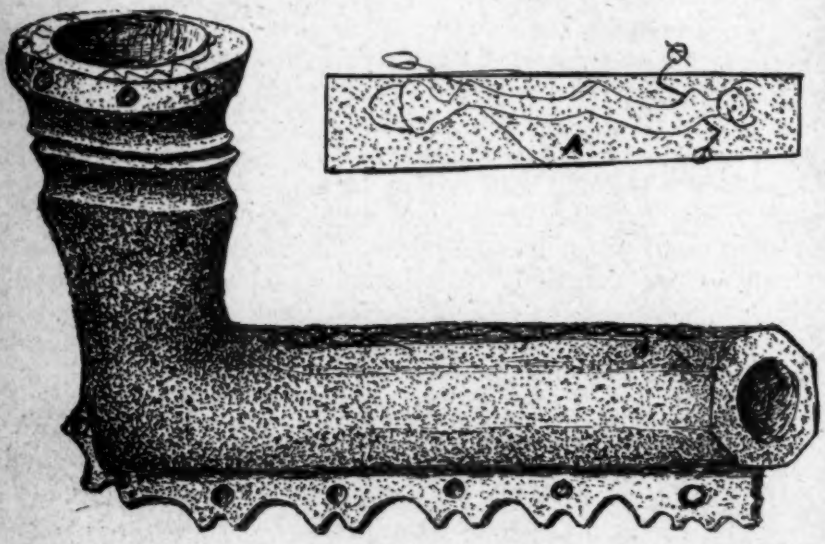


FIG. 10.

material was regarded as the petrified flesh of ancestors and was revered accordingly, and the single quarry where it could be obtained was a very sacred place. We often find this red pipestone mentioned by early writers, and it is strange that specimens made of it are not more often discovered, but they seem to be very rare everywhere, except, of course, those made in recent times.

The single specimen that has been found in the Champlain Valley was thrown out by the plow a dozen miles south of Burlington, and is shown in Fig. 10. It is made of the ordinary dark red catlinite, and has the form given in the figure. It is larger than most of our pipes, the stem being rather more than three inches long and the bowl about two inches and a quarter high. The cavity of the bowl is peculiarly excavated, as it is

strongly conical, being three fourths of an inch in diameter across the top and only a sixteenth of an inch at the bottom. On the flat upper side of the stem there are rudely scratched outline figures, as seen at A, and there are also outlines on the rim of the

FIG. 11.

bowl. The surface of this pipe is well polished. The inside of the bowl shows both circular and vertical striæ.

Stone tubes, of somewhat different form in different localities, have been found in almost every station which has been carefully searched for archæological specimens, and few objects have excited greater curiosity than these. Always well made, often of handsomely colored and veined stone, they have been regarded as pipes, musical instruments, medicine tubes, and even telescopes, by different authors. When one examines these tubes he very readily sees that it is more than probable that all can not be placed in the same class, for, not only do they vary in size very widely—some being only two inches long and of small diameter, while others are ten, fifteen, and rarely twenty inches in length—but the bore is even more variable, in some being as large as the outside will allow, and of uniform size from end to end; in others it is large at one end and grows smaller toward the opposite end, where it is often of no greater diameter than the bore of some of the pipestems. Very likely the tubes of the first sort were used in the performances of the medicine man, and those last named were used as pipes, as are the very similar pipes smoked to this day by Utes and other West coast tribes. The tubes appear to be everywhere rare, and yet no form of pipe so often occurs in the Champlain Valley, especially on the Vermont side.

FIG. 12.

Our Vermont tubes have a bore which is very much smaller at one end than at the other, and the small end was, I think, always stopped partially by a rudely ground and imperfectly fitting stone plug, as it certainly was in most cases, for we find the plug in some of the tubes. The general form of the tubes of this region is somewhat differ-

ent in each specimen, but Fig. 11 shows a typical example, the heavier line giving the outline of the bore. This tube is eight inches and a half long, nearly an inch and a half in diameter at the largest part, and about an inch at the smallest. The material —and this is the same in all—is a drab talcose slate. The figure is one third full size. Other tubes have been previously figured and described by the writer in the Portland volume of Proceedings of the American Association for the Advancement of Science. The tubes are all very carefully shaped and well finished. The bore was probably first drilled with a reed and sand, and then at the large end worked out by means of some pointed tool, for circular striæ are plainly seen at the small end, while at the other only longitudinal marks occur. Whatever may have been the design of other tubes, it seems by far most probable that those found here were used as pipes, for they are in all essential respects like those mentioned above, now and anciently in use on the Pacific coast, as may be seen by reference to the seventh vol-

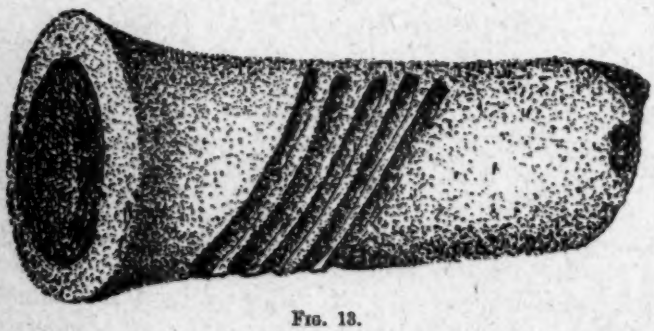


Fig. 13.

ume of the Wheeler Survey, Plates 7 and 8, and also to Volume III of the Contributions to North American Ethnology.

In Fig. 12 there is shown a pipe which may be considered as representing the transition from stone to modern forms; for, although it was dug in a locality that has yielded more of our stone pipes than any other, it is made of pewter. It does not appear as if cast in a mold, but rather as if worked out of a solid block in the same manner that a stone pipe would be made. The surface is covered with tool-marks, and the bowl bears inside both vertical and circular striæ. Of course, the material of which this specimen is made arouses suspicion that it was the work of a white man; but its appearance, as well as the circumstances in which it was found, all indicate that it is of Indian origin. The material was of course obtained from Europeans.

A people who had attained to such skill in working clay into jars as had the aborigines of the Champlain Valley would undoubtedly make many of their common pipes of this material,

and we find numerous fragments of earthenware pipes of various forms, but most of the specimens of this sort are merely fragments. A few entire pipes of the same mixture of clay and pounded stone which we have in the jars are in existence. One of these is shown in Fig. 13. Earthenware pipes of the same general form as that seen in Fig. 8 have also been found, and very likely this was the more common shape. The pipe represented in the figure is unusually thick and heavy, and apparently was made for service rather than ornament. It is three inches long, and the diameter at one end is an inch and a half, at the other about an inch. The bore is rapidly contracted, so that it soon becomes quite small. Most of the earthenware pipes of this region are very smooth on the outside, having received a finishing coat of fine clay, but this is without it, though the surface is tolerably smooth.

THE ESSAYS OF JEAN REY.

By MM. L. A. HALLOPEAU and ALB. POISSON.

AMONG the men of science of the first half of the seventeenth century the name of Jean Rey, doctor, of Périgord, was long forgotten and is still little known. He was born toward the end of the sixteenth century, at Bugues la Dordogne. Hardly anything is known of his life. He was a doctor of medicine, and devoted himself for several years to researches in chemistry and physics, in co-operation with his elder brother, also named Jean Rey, Sieur de la Perotasse, proprietor of the iron forge at Rochebeaucourt, la Dordogne. He died in 1645, and his days may have been cut short by grief over a disastrous lawsuit.

Jean Rey invented a water thermometer, or thermoscope, and a wind arquebus, and he even thought of applying his thermometer to the uses of medicine. It was certainly one of the first instruments invented to measure differences of temperature. In his description of it he said: "It is nothing but a little round vial with a long, uncorked neck. In using it, I place it in the sun or in the hands of a fever patient, after having filled it, all except the neck, with water. The heat, dilating the water, causes it to rise more or less, according as the heat is great or little."

He wrote one little book of a hundred pages, dedicated to the Count de la Tour d'Auvergne, which was printed in 1630, under the title of Essais de Jean Rey, Doctor of Medicine, on an investigation of the cause of the increase in weight of tin and lead when they are calcined. This work was not understood by the learned men of that period. It was probably not very widely published,

and only two copies of the edition existed in the middle of the eighteenth century. But one of these copies was complete. It belonged to the great library of the king. It was, however, reprinted in 1777 by Gobet, who also reprinted, about the same time, the works of Bernard Palissy. After the essays, Gobet published a part of Rey's correspondence with Père Mersenne relative to them, and there are probably still other letters in the manuscript correspondence of Père Mersenne. Rey's book was therefore well published at the close of the eighteenth century. Nevertheless, this edition, too, is now very rare, and only three copies exist in the libraries of France.

As very few persons of this age have read the Essays of Jean Rey, we have thought it might be of service and cast some light on the history of science, obscure in its beginnings, to give a brief but exact analysis of its contents. Judging by his writings, Jean Rey appears to have had very extended scientific knowledge and a talent for experimentation rare in his time. He was, furthermore, in pleasant relations with most of the learned men of the period, who were accustomed to consult him in difficult cases, while he was correctly informed of all that had been done in France and other countries. Three men in particular were closely associated with his works—viz., the Sieur Brun, master apothecary of Bergerac; Deschamps, a physician of the same city; and Père Mersenne, of the order of the Minims, who had a continuous and interesting correspondence with him.

Rey's experiments were undertaken at Brun's request. Brun's letter, giving as it does an idea of the confidence which Rey inspired among his contemporaries and of his high reputation, merits publication entire. He wrote: "Desiring a few days ago to calcine some tin, I weighed two pounds and six ounces of the finest English metal, put it in an iron kettle on an open furnace, and, stirring it continually without making any change in the adjustment, I converted it in six hours into a very white earth. I weighed it to determine the loss, and found that it weighed two pounds and thirteen ounces. This astonished me incredibly, for I could not imagine where the surplus seven ounces had come from. I performed the same experiment with lead, and calcined six pounds. I found it had gained six ounces. I asked the cause of this from many learned men, particularly from Dr. N. (Deschamps), but none of them could explain it to me. Your brilliant mind, which soars, when it is so disposed, above the common, will find matter to occupy itself with in this. I implore you with all my affection to employ yourself with the search for the cause of so rare an effect, and to oblige me so much that by your aid I may be enlightened respecting this wonder."

Rey immediately set himself to work to find the answer to this

question—one of "the most difficult that philosophy has ever brought forth." It was not without emotion that he took up the pen: "Believing I have reached the end of the matter, I produce these my essays, not without well foreseeing that I shall be called rash, for in them I shall disturb some of the maxims that have been approved for ages by most philosophers. But what can there be rash in exposing the truth to the light after having found it?" The book of twenty-eight chapters or essays is divided into distinct parts. In the first part the author, as it were, prepares his reader for the ideas he is about to set forth in the second. He first demonstrates the weight of the air—an entirely new fact in science then—and next he applies the ideas he has just enunciated to the explanation of the weight of lead and tin when calcined in the air.

The great physicists of the seventeenth century had as yet produced nothing when Jean Rey's essays appeared. Otto von Guericke was only twenty-one years old; Torricelli was still studying mathematics at Rome, and his celebrated experiment was not performed by Viviani till 1643. Galileo was the only one who might at that moment have had established ideas on the weight of the air, and his Dialogues on the Motion and the Resistance of Fluids was not published at Leyden till 1638.

Rey was therefore the first person who declared that the air has weight, and he alone has the right to all the honor for this important discovery. His first essay is entitled Everything Material under the enclosure of the Sky has Weight. He supposed that the earth occupied the center of the world. "Matter, filling at every point the space inclosed under the curvature of the sky, is continually urged by its own weight toward the center of the world. True it is that earth, being the heaviest, promptly occupies that place, and, forcing its contraries into retreat, makes water, second in weight, also second in place; so that air, driven from the lowest and the second place, is confined to the third, leaving to fire, the least ponderous of all, to abide in the highest region." Thus Jean Rey showed very precisely that all bodies have weight, that there is nothing light in Nature, and "no upward movement that is natural." Let us give his own words: "I say, if there was a channel from the center of the earth up into the region of fire, open at both ends and full of the four elements, everything in its usual place, that, on drawing the earth down, water would descend to occupy its place, leaving its own to the air, and the air leaving its place to fire. Then, withdrawing the water from that place, the air would come down to fill it; and this, too, being taken away, the fire would take possession of the vacant space and fill the whole channel, descending to the center, just by that being removed which prevented its doing so. Those

who say that this would be done to avoid a vacuum do not say much. They point to the final cause, and this demonstration concerns the efficient one, which rules that there can not be a vacuum." Rey's book, however, while it marked an immense progress in science, contains some considerable errors. Thus, he undertakes in his fifth essay to show, by the acceleration of the motion of falling bodies as they descend, that fire and air are heavy, and he attempts to prove by an ingenious but fallacious demonstration that they are forced down more and more rapidly by the increasing weight of the air and fire above them.

Having tried to "impress upon everybody's heart that air has weight," Rey announced the proposition, then new to science, deduced from this principle, that "weight is so closely joined to the primal matter of the elements, that changing from one to another they always keep the same weight. The weight which each portion of matter takes from its cradle it will carry to its grave. In whatever place, under whatever form, and to whatever volume it may be reduced, always the same weight." This principle, which he discovered more than a century before Lavoisier, was confirmed by a curious experiment of Brun's, who in 1644, having constructed a distilling apparatus, hermetically sealed, inclosed within it wood of guaiac, box, or oak, weighed the whole, and distilled it. The wood was destroyed; but a new weighing, made at the end of the experiment, showed that the total weight of the apparatus had not changed during the distillation. The experiment was a delicate one, and proves that they knew how to work in Rey's time. Mistakenly believing that water could change into air, Rey constructed an apparatus for determining what volume of air a given quantity of water would form. It consisted of a bulb (æolipile) in which water could be boiled, connected by a tube with a cylinder open at the top; a piston was worked in this cylinder. The piston was brought down to the bottom of the cylinder. Heat was applied to the æolipile and the water was made to boil or was "transformed into air"; the piston of course rose, under pressure of the steam or "water air," and the capacity of the part of the cylinder below it showed the volume of the air that was supposed to be formed. Then the æolipile could be removed, the opening from it into the cylinder stopped up, and the cylinder exposed to cold, when the piston would be forced down and the vapor frozen or turned into water. Unfortunately for himself, Rey did not personally try this experiment, or he might have anticipated Papin by half a century. But not more than a year after the publication of his essays—September 1, 1631—Père Mersenne said: "As to the experiments with the æolipile, I have made them; but it is a false imagination to suppose that the water which issues from

it is turned into air; it still remains water, and will naturally return to itself."

Resuming his study concerning the weight of the air, Rey observed that his predecessors had failed to find it because they had weighed the air in itself: "Balancing the air in the air itself, and not finding weight, they have thought that it had none. But let them balance water (which they know is heavy) in water itself, and they will find no weight there too; it being a fact that no element has weight when balanced in itself. Everything that is weighed in the air and everything that is weighed in water should, for an equal volume, have as much more weight as it has more matter than the air or the water in which the balancing is done." Air, he said, could be made heavy by mixing it with some foreign matter having more weight; by compressing its particles; or by removing the lighter portions. In demonstration of the first principle, Rey determined by experiment that moist or cloudy air was heavier than dry air; of the second, he showed that, if a globe was filled by a strong draft of air from a bellows, it would be heavier than the same globe "empty." He even tried to make use of compressed air in the construction of a wind arquebus, but he did not carry out his idea; and the honor of making this invention practical belongs to the Sieur Marin Bourgeois, of Lisieux. Inversely, Rey observed that if one takes a glass vial cold, warms it a little on a chafing dish, and weighs it, he will find that it weighs less, because air has gone out from it; and in order to find how much, the pipe should be put, still warm, into water, which it will suck up till as much water comes into it as air has gone out of it. Rey was, however, not the first who had observed this fact, for Drebbel had anticipated him. The converse of these principles was also enunciated by Rey, viz., that the weight of air may be diminished by purifying it from heavier foreign matter, by extending it to ampler limits, and by extracting its heavier parts. "Even the balance sometimes deceives"; for, "if we examine the balances, cases may be found in which the object weighed will appear heavier or lighter without adding or subtracting foreign matter; as when it has been contracted or expanded." In support of this view, Rey cited as examples the cases of a ball of feathers tightly tied up, which will weigh more than the same feathers loose; and of two ingots, one of gold and the other of iron, which will balance one another without having the same absolute weights, "for the gold occupies a smaller volume for equal weight, and consequently displaces less air." These views were confirmed about 1650 by the inventions of Otto von Guericke.

Rey was now able to answer the question put to him by Brun, and to explain the cause of the increase of weight shown

by tin and lead when they are calcined. "Now," he said, "that I have made my preparations, that is, have laid the foundations of my answer to his question" (as to the source of the seven ounces which the two pounds and six ounces of tin gained when heated for six hours; the difficulty of the problem was enhanced by its being necessary also to find the other matter required to compensate for the loss which the tin sustained through expansion in heating): "to this question, then, resting on the formulations already laid, I answer and maintain gloriously, that the increase in weight comes from the air, which has been thickened in the vessel, made heavy, and in no way adhesive, by the vehement and long-continued heat of the furnace; which air mingles with the earth (the frequent stirring aiding this) and attaches itself to the smallest particles; not otherwise than water makes sand heavy when sand is wet and the mass is stirred, by moistening and adhering to its smallest grains."

Several authors had already spoken of the increase of weight in metals on calcination. Cardan, in his Traité de la Subtilité, tried to explain the increase of the weight of lead in the formation of white lead by saying it was because the lead died and lost the celestial heat which was its soul and made it lighter; and added that an animal is always heavier dead than living. Rey remarked, in answer to this, that lead is void of life and can not be compared with the body of an animal, and showed that it was easy, by a known process, to recover the lead from its earth. Further, "nothing increases in weight except by the addition of matter or by contraction of volume," and this can not take place in the present case, even under Cardan's hypothesis, for the celestial heat in disappearing takes away matter, while on the other hand the volume increases perceptibly through the whole duration of the experiment. It will be noticed that Rey shared in the prejudice of his time in regard to the weight of animals increasing after their death, and with him many of the learned men of the period. Père Mersenne was the first to refute this error. He ascertained by experiment that a dog and a hen weigh more, though very little more, alive than dead, and wrote to Jean Rey, September 1, 1631, "You can yourself try the experiment without losing any of the blood, or a hair, or a feather, of the animals, by smothering them, as we have done."

Scaliger had undertaken to refute Cardan's assertions, and said that the increase in the weight of the calcined lead was caused by the fire consuming its aërated particles, comparing lead with the tile, "which is heavier baked than unburned." Nothing could be more simple than Rey's answer: "If the lead loses airy particles, would it not diminish in volume? On the contrary, it increases. And then, if this reason is correct, why do not

stones and plants increase in weight when they are calcined? I add, finally, that air which is forced into a globe full of it, coming out diminishes the weight of the vessel instead of increasing it, as Scaliger believes." He rejected the comparison of the lead with the tile, saying, "The tile increases in weight by the shrinking of its extent; the lead by the matter that is added to it."

Cæsalpin had supposed, as Libarius records, in explanation of the phenomenon, that the soot produced by the fire struck the roof of the furnace and fell back upon the matter. Rey answered that the soot would blacken the lead instead of communicating a white tint to it. Moreover, if this were the cause, the production of earth might be carried on indefinitely by keeping up the fire, which was not the case. Libarius said that even apprentices in chemistry would laugh at Cæsalpin's theory.

Rey also showed that the increase in weight could not come from the iron vessel in which the calcination took place, for the earth would not continue white in contact with the dust of iron; besides, the vessel would be consumed in two or three operations, instead of being serviceable every day for several years; and, finally, if it was so, we should obtain from a very small quantity of tin or lead a very large quantity of earth, which is contrary to the experiment. Furthermore, a German chemist, Modestinus Fachsius, who also occupied himself with the question, concluded from the examination of the metals, the cupel, the lead, and the metal under trial, that all are heavier after the calcination than before they were exposed to the fire.

Deschamps assumed that the increase of weight was due to vapors of charcoal traversing the vessel. Rey answered that such vapors could not traverse a globe of glass, a plate of tin, or an earthen pot, because boiling water, sauces, and potages were not infected by them. How, then, could they traverse an iron vessel? Even if they did, why should they stop in the earth instead of going on?

Deschamps did not stop with this, but insisted that charcoal had two parts or natures, a vegetable and a metallic nature, and that each of them had two others, one fixed and the other volatile. The fixed part remains in the ashes, from which a fixed salt can be obtained by washing; but the volatile part, being of a mercurial nature, ascends around the vessel; and he made the objection to Rey's proposition that "the volatile part, lifted up on the wings of moisture, meeting the air which is directly on the vessel, being more rarefied and less heavy than the vapor that issues from the coal, is taken up by that in the vessel, and attaches itself by a close sympathy to the fixed salt of the earth of tin, which, having taken a certain quantity of it, and being, as it were, satiated, rejects the surplus." This observation, purely theoretical and made by

a man of science, has a curious appearance now, but was all in place in Rey's time. Rey, who had answered the other objections by argument, had recourse this time to experiment. "If a furnace is built in a wall separating two rooms, in such a way that the vessel shall be on one side and the ventilating registers and doors for feeding in coal on the other, I maintain that the increase in weight will still take place, although no vapors can enter the chamber containing the vessel. I have confirmed this by an experiment which I made at the forges of Jean Rey, Lord of Perrotasse, my elder brother, where I found the increase in tin, which I calcined on a pig, as they call it, or an ingot of sixteen or twenty quintals of iron, at the instant when, coming out of the furnace, it was cast into its mold; for it can not be said that vapors of coal contributed anything to it. Therefore, the volatile salt can not be accepted in this case."

Finally, with a single experiment Rey swept away all the objections in a lump. "I have just read in Homerus Poppius," he said, "in the third chapter of his book entitled *Basilica Antimonii*, of the new way that he practices in calcining antimony. He takes a certain quantity of antimony, weighs it, and having pulverized it, puts it in the shape of a cone on a marble; then takes a burning mirror, holds it in the sun so as to bring the pyramidal point of the reflected rays upon a point of the cone of antimony, which fumes abundantly, and in a little while the antimony, touched by the rays, is turned into a pure white earth, which he separates with a knife and turns the rays upon the rest till all has been turned white, and then the calcination is done. It is a wonderful thing that, although in this calcination the antimony loses much of its substance in the vapors and fumes that exhale from it copiously, its weight increases instead of diminishing. Now, if we ask the cause of this increase, will Cardan say that it is the disappearance of the celestial heat? That has been infused more largely by means of the solar rays. Will Scaliger say that it is by consumption of the airy parts? Thinning into earth and increasing in volume, it forces more in. Will Cæsalpin allege his soot? There is no fire to produce any soot. Does the vessel give up any of its own substance? Indeed, the rays are conducted so directly upon the matter that they do not touch the marble. Do you speak of the vapors of charcoal? No charcoal is used in this transaction. The volatile salts which have been so ingeniously brought forward lose here all their savor and grace. Perhaps moisture will be suggested, as has been recently done by some one. But where can it come from? From the marble? No, no, that is not conceivable. From the air? Still less; for the operation is best practiced in the warm days of summer, in the most violent heats of the dog star."

The final objection to his theory was one of Rey's own suggestion: Why does not earth go on increasing in weight indefinitely? Because "the thickened air attaches itself to it and continues to adhere to the most minute of its particles, so that its weight goes on increasing from the beginning to the end; but when it is all enveloped in air it can not take any more." He concludes then, and terminates his treatise by declaring with pride that he has found the real way of the truth, breaking the road for his successors, and advising them not to go astray from it.

This is the summary of the works of Jean Rey. A skillful experimenter, he knew how to use the balance, and it was the balance that suggested to him the result of his experiments. His book is a brief one. A single principal experiment is described, a single object is pursued in it. But he made two great advances in science. He discovered the weight of the air, being the first to publish that hypothesis, and verified it by experiments in chemistry and physics. The increase of the weight of lead and tin on calcination had been noticed for a long time by the alchemists, and even Galen knew of it. But nobody before Rey found that the cause of that increase in weight came from the air —from that thickened and heavy air. It was certainly a remarkable achievement to announce such a fact at a time when chemistry had made so little advance. No gas was yet known; and it was not till about 1719 that a misunderstood man of science, Mortrel d'Élément, found means to decant air through water into bottles, and taught in a public lecture in Paris "how to make air visible and perceptible enough to measure it in pints or in whatever quantity you will." It was not his fault, therefore, that he did not advance further.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

As a possible solution, or working hypothesis, of the reason of the migration of birds, Canon Tristram suggests: "Instinct in mammals and birds attracts them to the place of their nativity. When the increasing cold of the northern regions, in which they all had their origin, drove the mammals southward, they could not retrace their steps, because the increasing polar sea, as the arctic continent sank, barred their way. The birds reluctantly left their homes as winter came on and followed the supply of food. But as the season in their new residence became hotter in summer, they instinctively returned to their birthplaces, and there reared their young, retiring with them when the recurring winter impelled them to seek a warmer climate. Those species which, unfitted for a greater amount of heat by their more protracted sojourn in the northern regions, persisted in revisiting their ancestral homes, or getting as near to them as they could, retained a capacity for enjoying a temperate climate, which, very gradually, was lost by the species which settled down more permanently in their new quarters, and thus a law of migration became established on the one side, and sedentary habits on the other."

SKETCH OF SIR DANIEL WILSON.

By HORATIO HALE.

THE late President of Toronto University was distinguished not only for his educational work and his achievements in science, literature, and art, but also for the happy combination in his mind and character of qualities which are commonly deemed incongruous. An ardent votary of science, prepared to follow every investigation of Nature to the utmost limit of actual knowledge, and to welcome every accession to this knowledge, he was equally firm in maintaining his belief in the religion which explained to him those mysteries of the universe that lay beyond this limit. Strongly conservative of ancient landmarks in his quality of artist and antiquary, he was in education and in politics fearlessly liberal and progressive. Endowed with an energy of will and an intellectual power which inevitably brought him to the leadership of any enterprise or institution in which he took part, he was at the same time utterly devoid of personal ambition, and shrank from titular honors with the same earnestness with which some are wont to seek them. Generous almost to a fault and careless of the arts of money-making, his natural foresight and indefatigable industry preserved him from the pecuniary troubles by which scholars and writers are too often hampered, and secured for him throughout his life that good fortune for which poor Burns vainly sighed, "the glorious privilege of being independent."

Sir DANIEL WILSON was born in Edinburgh on the 3d of January, 1816. His father, Archibald Wilson, was a merchant of that city; his mother was a woman of rare natural gifts, who fostered in her children the love of knowledge which they inherited from her. Of a large family, only four—two sons and two daughters—survived to mature age. The sons, George and Daniel, both proved to possess talents which insured them early distinction. George, a physician, became Regius Professor of Technology in the University of Edinburgh and Director of the Industrial Museum of Scotland. Though he died at the early age of forty-two, he had already gained a European reputation. To his biography, written by his sister, Daniel contributed reminiscences which are of interest as indicating the existence in childhood of tastes which afterward became prominent. "Edinburgh," he writes, "was the scene of all our youthful years, and that itself was no unimportant element in life's training. Among my earliest recollections are scramblings on Arthur's Seat, where we knew every cleft and gully. A Saturday's ramble carried us away to old Roman Cramond, where the sculptured eagle of the legionaries of the second cen-

tury, still visible on the rocks, was a source of never-failing wonder to us. The ruins of Bothwell and Crichton Castles, of Roman camps, and historical scenes already possessed an interest for us. A good deal of antiquarianism mingled with our natural history, and two of us were already embryo numismatists, and knew a Roman denarius from a bodle as well as Edie Ochiltree himself."

Daniel's education was commenced in the famous High School of Edinburgh, whence he passed to the still more famous university of that city. At this period the special turn and capacity for art which he always retained was so strong as to induce him, on his graduation, to decide to make the pursuit of it his profession. With this object he removed to London, where a notable group of great painters was then rising into fame. At their head was Turner, with whom he soon became intimate. He describes him as an "old, slovenly, slouching little man, as remote from the ideal of artist or poet as could well be conceived; but the flash of his keen gray eyes redeemed the face from the otherwise vulgar and sensual look." The door of the strange house in Queen Anne Street was freely open to the young student; and he found in his repeated visits that the great painter could be kind and genial to an enthusiastic youth, while grimly ridiculing his enthusiasm.

In 1840 Wilson brought to London as his bride a Scottish lady. They had three daughters, the first of whom was born in London. She died ten months later, when with her mother visiting the old home. This affliction changed the course of the parents' life. They decided to return to Edinburgh, and Wilson, giving up art as a life-pursuit, devoted himself to literature. His diligent pen and varied talents soon found ample occupation. "He was," we are told by one of his biographers, "a constant contributor to The Scotsman, and wrote for Tait's Magazine, Chambers's Miscellany, the British Quarterly, North British Review, Edinburgh Philosophical Journal, Gentleman's Magazine, and other periodicals. He contributed articles to the edition of the Encyclopædia Britannica then in progress, as well as to subsequent issues, and he edited for a time the Proceedings of the Scottish Antiquary. He also prepared for friendly publishers some historical books, which, though creditably written, he afterward refused to include in the list of his acknowledged writings, counting them mere compilations and craftsman's work, as distinguished from the productions of original research, to which he was soon to owe his fame.

The first of these was published in 1848, under the title of Memorials of Edinburgh in the Olden Time, by Daniel Wilson, Acting Secretary of the Society of Antiquaries of Scotland. It filled two quarto volumes, illustrated throughout with fine engravings of the buildings and localities described, all from his own drawings. The pictures are enlivened by characteristic

figures of people engaged in their ordinary vocations, presented with a life and spirit which show how far superior in these qualities the higher efforts of the draughtsman's art are to the best photography. The description and historical explanations evince deep research, combined with a genial temper and lively humor, which make the work attractive reading. It has been twice reprinted, the latest revised edition appearing in 1890. In his next publication the author found a subject of wider scope, and assumed a higher position. He had passed from art to literature, from literature to archæological study, and now emerged on the loftier plane of pure science, to which his intellectual tastes and faculties naturally tended. In 1851 appeared his Archæology and Prehistoric Annals of Scotland, which was revised and reproduced in two volumes as Prehistoric Annals of Scotland, in 1863. The expressive adjective "prehistoric," which was first employed in this title and work, has since made its way into the language of almost every civilized nation, and in France constitutes, as *Le Préhistorique*, the title of an important science. In his preface the author dwells earnestly on the importance of this science of prehistoric man, and expresses his surprise that "the British Association, expressly constituted for the purpose of giving a stronger impulse and a more systematic direction to scientific inquiry, embraced within its original scheme no provision for the encouragement of those investigations which most directly tend to throw light on the origin and progress of the human race. Physical archæology was indeed admissible, in so far as it dealt with the extinct fauna of the paleontologist; but it was practically pronounced to be without the scientific pale whenever it touched on that portion of the archæology of the globe which comprehends the race of human beings to whom we ourselves belong." A delusive hope had been raised by the publication, in the first volume of the Transactions of the Association, of "one memoir on the contributions afforded by physical and philological researches to the history of the human species"; but the ethnologist was doomed to disappointment. From that time all papers relating to this important branch of knowledge had been constantly rejected. It was no small triumph for Sir Daniel Wilson when, thirty-three years later, at the Montreal meeting of the British Association, in 1884, in which he held a prominent position, anthropology was admitted to the rank of a distinct "section," and a committee was appointed, of which he was a member, to investigate the tribes of northwestern Canada—a committee from which very extensive reports of "physical and philological researches" have been warmly welcomed by the Association, and have formed a conspicuous feature of its recent volumes.

The publication of this work changed his entire career. The

high reputation which it gave him—a reputation sufficiently indicated by Hallam's opinion that the book was "the most scientific treatment of the archæological evidences of primitive history that had ever been written"—procured him the appointment, in 1853, to the chair of History and Literature at University College in Toronto. He removed to that city, and, as one who knew him and the colony in those days has written, "he brought a new element into the life of the place, and indeed of the province. Representing 'letters,' and winning favor to them by his eloquent speech, in a community too much absorbed in business, he has left his mark clear and deep on young Ontario and the whole Dominion. Thousands have been consciously benefited by his character, life, and works." From this time till his death, nearly forty years after, his life was bound up with the interests of the college. It was his boast that for thirty years he never omitted a lecture. The work of his professorship harmonized with his tastes, and gave him a field in which his powers were soon felt. "As a lecturer in history," we are told, "he was noted for the breadth and liberality of his views, and for the spirit of toleration and courtesy which he displayed toward those who differed from him. In archæology and ethnology, subjects peculiarly his own, he never failed to excite interest, and generally succeeded in arousing no small degree of enthusiasm."

But other and less congenial duties were frequently cast upon him. The large endowment granted by the Government to the secularized university was deemed by the denominational colleges an injustice and an injury to themselves. A determined effort was instituted by their supporters to secure a division of it among the different colleges. An appeal was made to the Legislature, which referred the question to a committee. Before this committee, Prof. Wilson, as the foremost member of University College, was appointed to appear and defend the interests of his college and the cause of secular education. This he did with so much force of argument that the hostile attempt was promptly defeated, and was never afterward renewed. All controversy was distasteful to him, but when a cause dear to him was endangered, and the "perfervid Scottish temper" was once aroused, he could strike heavy blows. In the present case the usual reluctance was felt, but finally, he wrote, "I plucked up heart of grace, and found a grim satisfaction in mauling the assailants of our college militant."

In 1880, on the death of the Rev. Dr. McCaul, who was the first President of University College, Prof. Wilson was promoted to that office. The position gave at last the needed opportunity for the display of his remarkable energy and organizing talent, always directed by a judicious forethought and impelled by an un-

tiring zeal. In a sketch written soon after his death, we are told that "the twelve years of his *régime* have been marked by an extraordinary rapidity of development in various directions. The attendance of students has greatly increased, so that they now number about five hundred in the faculty of arts alone. The teaching medical faculty has been restored to the university, and is now in a highly prosperous condition. A foundation for a law faculty has been laid. The university has been brought into more effective and beneficial relation to the secondary schools, by the establishment of a co-operative supervision over their leaving examinations. During the past six years women have been permitted to attend lectures in the university and University College, their number being now about one fifth of the whole attendance, and the ratio rapidly increasing. Several additional institutions have been taken into affiliation with the university, which has thus been strengthened with the whole community, as well as with many special and powerful interests."

As originally established, the University of Toronto and University College were to a certain extent distinct institutions. The university was simply an examining and degree-conferring corporation, while University College was a teaching institution, with a faculty of arts. By a recent change, part of the teaching function, comprising all the work in science, philosophy, and history, has been transferred to the university; and as a result, the President of the College became actually, as he had been in common parlance, the President of the University.

For the interests of science and literature it was probably fortunate that Prof. Wilson's accession to the college presidency, with the consequent great increase in his scholastic duties, did not occur at an earlier day. During the twenty-seven years which elapsed between his arrival in Toronto and this accession, he had leisure to pursue his studies in various directions. In 1862 appeared his most important work, entitled Prehistoric Man: Researches into the Origin of Civilization in the Old and the New World. This work attracted much attention on both continents, and gave a new direction, particularly in Germany, to anthropological inquiry. A second edition appeared in 1865, still in one volume. The continuing demand and the growth of scientific knowledge called for a new and revised issue, with many additions, which appeared in 1875, in two large and finely illustrated volumes.

The author's literary taste and judgment were happily shown in his admirable book, Chatterton: a Biographical Study, which appeared in 1869. It was a thoroughly successful effort to rehabilitate the moral character of the "marvelous boy," as well as to display the real nature and extent of his surprising intellectual

powers. The attraction which drew the biographer to his subject was doubtless the similarity of archæological and poetical tastes. Early in life he had published—like Chatterton, under an assumed name—a little volume of verse, entitled Spring Wild Flowers: Poems, by Wil. D'Leina, of the Outer Temple. By request of the publisher, the collection was reprinted in 1875, with the author's name, and with a modestly deprecatory preface, in which he solicits indulgence for these "sins of his youth." But an impartial critic would find nothing to offend and much to be admired in the volume. Caliban: The Missing Link, appeared in 1873, a genial, half-humorous, and wholly shrewd and happy commentary on Shakespeare, Darwin, and Browning, full of keen suggestions, which the admirers of those famous authors would do well to study with care. The vivid recollections of his early home appeared in his Reminiscences of Old Edinburgh, published in 1875, in two charming volumes of mingled history, description, and gossip, beautifully illustrated by pen-and-ink sketches from the author's hand, in his peculiarly vivid and animated style. Among other claims which may be made for this work is that of being the best commentary (next to Scott's own) on the famous "Scotch novels" of the author's illustrious townsman.

For a time the duties of the presidency interrupted Sir Daniel's authorship. But in 1891 appeared a volume on Left-handedness, comprising, as a reviewer remarked, "a careful and comprehensive discussion of the origin and nature of the prevailing distinction between the uses of the two hands and the consequences which follow this distinction." Sir Daniel was himself left-handed; but, like other eminent men who have been subject to this apparent disability—including a personage no less distinguished than the illustrious artist and mechanician, Leonardo da Vinci—he was able to convert it into an advantage by the simple process of cultivating the use of his right hand, and thus making himself ambidexterous. He was accustomed to write with his right hand and draw with his left; and both his handwriting and drawing were of unusual excellence. This volume was followed in 1892 by his latest work—and, as it proved, a posthumous publication—entitled The Lost Atlantis and other Ethnographic Studies. This was a collection of essays on various ethnological and archæological subjects, reprinted from the Transactions of scientific societies, and chiefly from those of the Royal Society of Canada. The volume of four hundred pages comprises only eight essays, but each of them, as a reviewer has said, "is a complete monograph on the special subject to which it relates; and every subject has its peculiar interest and value to students of history and the science of man." These subjects comprise, besides the well-known Atlantis legend, The Vinland of the Northmen, Trade

and Commerce in the Stone Age, Pre-Aryan American Man, The Æsthetic Faculty in Aboriginal Races, The Huron-Iroquois—a Typical Race, Hybridity and Heredity, and Relative Brain-weight and Size. The volume may be said to fitly sum up its author's life-long studies of these important topics.

But this anticipates. Sir Daniel's later years were marked by events of grave moment. In 1885 a great and irreparable personal loss befell him in the death of his wife, "after forty-five years of as great wedded happiness as ever fell to the lot of man." The event made little change in his outward demeanor; but how deeply it affected him was shown three years later, when the honor of knighthood was unexpectedly bestowed upon him. In general, as has been said, he cared nothing for merely titular distinctions. For her sake, to gratify her wifely pride and affection, this honor might have been acceptable. As it was, he at first positively declined to accept the title. But pressure from all sides came upon him. He wrote in his own amusing vein: "I have had the honor and glory of knighthood for a full week—telegrams, cable messages, letters of congratulation, time for little else but replying. To a jolly old bumble-bee the process of feeding on honey and being smothered in rose leaves is probably the ideal of happiness; but to a wingless biped like myself a little goes a long way. And what are most covetable honors, now that my Maggie is gone?" But the friendly urgency proved too great for resistance, and he yielded at last to the general desire of the community, which, reasonably enough, saw in the title simply an evidence of well-earned respect and public gratitude.

Not long afterward, his unremitting labors for the advancement of his university were interrupted by a serious calamity. On the 14th of February, 1890, a fire broke out in the principal college building, which destroyed nearly the whole of its contents, including its fine library of thirty-three thousand volumes and most of its museum collections. The president's action was characteristic. Instead of being depressed by the blow, as might have been expected in a man of seventy-four, his spirit rose with the occasion. He was early on the ground, giving every assistance in his power to rescue what could be saved. Returning home late at night, he said to one anxiously watching for him: "Well, the old building's gone; but never mind. It wasn't large enough for us. We'll soon have a better one." To a colleague who came in a few minutes later, saying, "O Mr. President, don't be discouraged," he replied: "Discouraged! I should think not. You'll see, we'll soon have a far finer building." Before sleeping that night he had formed his plans. On the next day, which happened to be Saturday, he so arranged for Monday's lectures being held in various buildings kindly placed at his disposal, that

the college and university work continued without the interruption of a single lecture. Hundreds of letters poured in, but not one of them was left without a suitable reply. "Courtesy does not cost much," was his frequent answer, when urged to take no notice of seemingly trivial letters. Encouraged by public sympathy, and bent on seeing his much-prized university more than itself again, he seemed to renew his youth. "Sir Daniel is the youngest man in college," was a common saying at the time. "I mean," he wrote, "not to bate heart or hope; but trust, near as I am to the goal of life, to see the renovated pile in its old beauty, and vastly improved within." This hope was fulfilled, mainly, it may be said, through the influence of his own great reputation and the character for liberality of comprehension, irrespective of class, creed, or race, which he had stamped upon the institution. Offers of substantial aid to the building fund, the library, and the museum came from numerous and often unexpected quarters in Europe and America, including a generous contribution from the Legislature of Roman Catholic Quebec. So rapidly was the work of renovation pushed on that at the college "commencement" of 1891 he was enabled to give his presidential address—one of the most eloquent and brilliant, and unfortunately, as the event proved, the last of his efforts in that line, in one of the new halls; and before his death the restoration of the university, in a condition far superior to that which it held before the fire, had been practically completed.

Among other honors it may be mentioned that he received the degree of LL. D. from the University of Aberdeen, and later also from McGill University, of Montreal, of which, at an earlier day, he had been offered the presidency. He was for several years President of the Canadian Institute of Toronto, the leading scientific association of Ontario. When the Royal Society of Canada was founded by the Governor-General, Lord Lorne, he was at first made president of its Literature Section, and three years later was elected president of the society. He was a member of various learned societies in Europe and America, too numerous to mention. In religious and charitable associations at home he was an active worker. He aided in founding Wycliffe College in Toronto, and was at his death a member of its governing board. The newsboys of the city attracted his special care, and it was mainly through his efforts that the "Newsboys' Home," a most useful and well-managed charity, was founded and maintained.

Near the close of his life one special honor came to him which he highly prized. In the summer of 1891 he paid his last visit to Scotland. While he was there, the "freedom" of his native city was, with much public ceremony and cordial demonstration, conferred upon him, and he thus happily "renewed his youth as the

youngest burgess of the guild." His portrait was also painted by request, that it might have a place in the Scottish Portrait Gallery. It now hangs there, an admirable work of art by Sir George Reid, President of the Scottish Academy. To Sir Daniel, Edinburgh was (in his own words) "as Jerusalem was to the royal Hebrew, or the city of the violet crown to the old Athenian"; and these marks of the esteem and personal regard of his early friends and their children were specially grateful and cheering. On his return home the elasticity of his spirits was noted by his friends and correspondents. A busy winter followed, in which his energy and intellectual force showed themselves in no way abated. Then, almost suddenly, the end came. A brief and nearly painless illness closed with his death on August 6, 1892, in the seventy-seventh year of his age.

His life was, as he himself said, "a singularly happy one." "I have been fortunate," he wrote, "beyond my deserts, and seem to have had far more than my share of God's best gifts." The qualities which insured this singular happiness appear to deserve particular note. A naturally sanguine and sunny temperament had doubtless much to do with it, but the main element was unquestionably his entire unselfishness. His thoughts were constantly for others, and were only for himself so far as the power of serving others was concerned. This disposition was quickly evident to all with whom he came in contact, and was evinced in many ways, great and small. "His colleagues," we are told by one who knew him intimately, "noted his extreme thoughtfulness for others and forgetfulness of self. This naturally led to harmonious relations and strong attachments. One writes, "My friendship for him is one of the sweetest recollections of my life"; and he was not alone in the expression of such a feeling. In his students he took a deep personal interest, frequently inviting them to his house. In their debating societies, sports, and Young Men's Christian Association they could always rely on his practical sympathy. No length of years diminished his interest in a former student's fortunes. The result was a strong affection for him, which was displayed whenever an occasion offered.

A striking characteristic, we are told, "was his unfailing fun. It made his home a very merry one. His letters are full of it, and remind one of Thackeray in their humor. With his students a joke was a more potent weapon for maintaining order than a reproof. He would cleverly turn the laugh of the class against some idler or disturber of the peace. Senate and council meetings were relieved of their tedium by his ready wit; and when in good spirits—and he was rarely otherwise—he was a great acquisition to any social gathering. In early days he wrote valentines for his daughters, and was found out in delivering one of

them by losing his spectacles, which had to be recovered the next day."

He shone as a correspondent. Few idle men kept up so large a correspondence as this extremely busy one. His letters, frank, cordial, sympathetic, full of lively touches, apt suggestions, and pleasant reminiscences, were highly prized by all who were favored with them, and gave naturally to strangers who read them a most pleasing impression of the writer's character. The fortunes of his friends were always in his mind. Nothing of joy or sorrow could happen to one of them without eliciting from him a letter of sympathy, which exactly fitted the need. The dumb animals about him—"My poor relations," as he was wont to style them—shared his tenderness. Long after his death, "a favorite cat haunted his vacant study, evidently seeking the friend who would rather resign his favorite chair than have her disturbed." His benevolence was not undiscriminating, as the regulations of his "Newsboys' Home" sufficiently show; but in his private charities he allowed himself a freer hand and, so to speak, a willing credulity. "He was a perfect fortune to beggars. Taken in again and again, every new applicant seemed to him 'a very decent-looking fellow,' especially if he happened to be Scotch. And if nothing else could be said, he would excuse his generosity by 'It's hard to be poor,' or 'I was once poor myself.' He did, indeed, note that the word 'borrow' seemed to have no connection with that other word 'repay'; but he went on lending still." A poor woman who, coming to ask for him, found crape on the door, went away saying, "The blessing of those that consider the poor will surely fall on him and his."

It is easy to predict that this singularly fine character, illustrious for many great qualities and achievements, and with no shadows except such pardonable failings as "lean to virtue's side," will shine brighter in becoming better known, and will be hereafter ranked among the beacon-lights of the age. In the scientific world, the large-minded and far-seeing scholar, who first gave a place and a name to the science of "prehistoric man," must always be a conspicuous figure.

In his presidential address before the Geographical Section of the British Association, Mr. Henry Seebohm expressed the opinion that life areas or zoögeographical regions are more or less fanciful generalizations. Animals recognize facts, and are governed by them in the extension of their ranges; they care little or nothing about generalizations. The mean temperature of a province is a matter of indifference to some plants and to most animals. The facts that govern their distribution are various, according to the needs of the plant or animal concerned. Actual temperature governs them, not isotherms corrected to sea level.

CORRESPONDENCE.

A CRITIC CRITICISED.

Editor Popular Science Monthly.

ANY one who reads the book notices in journals wherein literary criticism is conducted as it is in many important newspapers will be impressed with the necessity of abolishing the custom of anonymous reviews, if we are to have any criticism worth anything. Under the present system such notices are the work largely of flippant critics, competent only to frame condemnatory epithets, who assume to judge everything without special knowledge of anything; and also of those who have special acquaintance with the topic in hand, but are consumed by feelings of jealousy which prompt them to underrate, to disparage, to stab in the back, to break down reputations acquired, or to prevent the acquiring of any on the part of new authors who may apparently be rising. All these things can be done and are done constantly under the system of anonymous criticism. The critic is safe in his concealment, and can send forth his poisoned arrows with impunity. Whether he is a giant or a dwarf can not be known, save, perhaps, by his weapons; but if, as is usually the case, he is a pygmy, he is not less dangerous, since retaliation is impossible.

The New York Evening Post of October 25, 1893, contains a notice of Mr. Herbert Spencer's latest volume, Parts V and VI of the Principles of Ethics, which furnishes a complete illustration of the degradation of criticism. If there were space I would ask the editor of The Popular Science Monthly to reprint it as such, without comment. But, since the article can not be reprinted, I shall draw attention to one or two of its features. It begins by assertions of the marvelous dullness of Mr. Spencer's works, his "cheap and superficial platitudes," making him "an accomplished artist in tedium." This certainly is a novel charge to be brought against the author in question. Of all the modern philosophical writers, according to the general judgment expressed in numberless reviews, notices, and comments published here, there, and everywhere, Mr. Spencer has been esteemed the one most free from the quality of tediousness! His power of holding the reader's attention without wearying, his lucidity of statement, his felicity in illustration, make his books eminently readable. Of course, they imply a capacity to take hold of thought, but, if this be presupposed, few readers will call Mr. Spencer dull. As to the matter of platitudes, it never occurs to the average reviewer that criticising a scientific writer on this score is often much like criticising a sculptor or painter because his work is true to life. If the philosopher keeps within his topic, it is evidence of his greatness that his statements are so clear, so true, that they seem indisputable. It is his crowning excellence that he says things which the reader recognizes as so evident that he believes he himself and everybody else must always have held the same ideas.

The writer in the Post endeavors to disparage Mr. Spencer's work by the old charge that he is no scholar, that he reads little and knows little of the progress of modern thought. He claims that Mr. Spencer has admitted his ignorance of Kant and is not familiar with German idealism, while the list of authorities he cites is "crude and uncritical material." It is difficult to deal with these charges of little scholarship and failure to know what is significant in philosophical literature, in any other way than by a flat contradiction. That Mr. Spencer has not read everything in German philosophy, or in recent philosophical literature of other countries, is no doubt true, but any one who knows Mr. Spencer's habits is well aware how careful he is to ascertain what literature is produced from time to time and its bearings upon philosophical truth. For an ignorant man and one who takes no note of what is passing in the world Mr. Spencer shows a remarkable aptitude for getting hold of facts and theories bearing upon his own doctrines, as is evinced in his recent discussions of Prof. Weismann's theories in the Contemporary Review. If, then, a critic declares Mr. Spencer has fallen behind the times, he may discover, if he makes inquiry of those who know what Mr. Spencer does, that it is easier to write misleading statements for a newspaper than to prove them when challenged. Perhaps it is expected of Mr. Spencer that he will turn aside from his work and prepare book reviews, to demonstrate his scholarship and his familiarity with questions of present importance in philosophy. But if he should have no better success in that way than his anonymous critic, it would scarcely be worth his while.

This critic is especially severe because, as he says, Mr. Spencer, in a passage quoted, "represents every operation of the mind as a recognition of a likeness or the recognition of an unlikeness. According to this, every operation of volition, every operation of going to sleep, and every other mental operation is but an act of recognition." The passage quoted by this able reviewer is this (Italics mine): "One division of an earlier work in this series of works—the Principles of Psychology—was devoted to showing that all *intellectual* operations are ultimately decomposable into recognitions of likeness and unlikeness." The writer who assumes to inform

his constituency so confidently of Mr. Spencer's paucity of knowledge and his general decrepitude does not seem to know that intellect, feeling, and will are three depart ments of mind, and that Mr. Spencer's statement is applied to one only. "Intellectual operations" are *not* all the operations of mind. What Mr. Spencer says he may be criticised for, not what his blind critic avers that he says. Yet this perversion with its comments occupies a long paragraph.

I have not space for further illustration of the heedless, dogmatic, crude, and false statements with which this worthless critique abounds; but the public will be exposed to its like so long as anonymity is the fashion in book reviews.

DANIEL GREENLEAF THOMPSON.

NEW YORK, *October* 30, 1893.

COLORED AUDITION.

Editor Popular Science Monthly:

DEAR SIR: Struck with M. Binet's paper, The Problem of Colored Audition, in The Popular Science Monthly for October, without questioning the facts, when consulting my own recollections I was unable to recall any one who possessed such curious powers.

Happening to meet to-day a young lady, the talk was about pleasant or unpleasant voices, such as are in use in ordinary conversation. Both of us commented on the voice of a person of our acquaintance, when the lady said: "So-and-so has a green voice. It always sounds green to me."

Without bringing M. Binet to the front, I questioned the lady in regard to this color comparison. I found that voices, intonations, and sounds had positive color effects on her mind. There was a gentleman whose voice was "red" to her. Then I asked her if she had read M. Binet, and she said she had no acquaintance with the article published by you, nor had she any conception that there was anything peculiar in her associating tones with colors. She said she always did it.

Respectfully, BARNET PHILLIPS.

BROOKLYN, *October* 6, 1893.

EDITOR'S TABLE.

SCIENCE AND CIVILIZATION.

THE close of the great Columbian Exposition at Chicago naturally suggests reflections as to its general significance and import. The Exposition was meant to furnish a conspectus, as it were, of what the art of man is able to accomplish toward the end of the nineteenth century; and, as a memorial of the civilization of to-day, its general catalogue would be to future ages a most important document. That the Exposition as a whole was a vast and overwhelming demonstration of the resources of modern life, no one can question. Until the riches of the world are gathered together in some such way we wholly fail to realize, and even when they have been so gathered together, we but imperfectly—very imperfectly indeed—realize what the achievements of our age have been. When the idea has, however, in some measure been brought home to us, we involuntarily ask, What has made our age to differ so much from past ages, when whole centuries would pass with very little change in the outward conditions of society? The answer lies on the surface: The modern world has found the key to real knowledge. In former ages a certain number of useful arts were discovered empirically and more or less fortuitously; to-day we have learned how to make discoveries, as it were, by rule. We regard Nature as a book, every leaf of which contains useful lessons, written sometimes in characters difficult to decipher, but always decipherable in the end if but proper pains be taken and proper methods pursued. In former ages men's minds were possessed by a number of absolute notions and *a priori* principles which they applied to the interpretation, or rather misinterpretation, of Nature; and as a consequence the discovery of truth lagged and languished. How greatly, for example, was the progress of astronomy retarded by the assumption that as the circle was a perfect figure, the planets must move in circles; that

because the earth was big to the eye and the sun small, the former must be the central orb and the latter the satellite; that mystic powers resided in certain numbers, and so on! To-day we come to Nature as simple questioners, not telling her what she must be, but asking her what she is, and what are her laws. A certain amount of knowledge, of course, we have gained, and this we use as capital for the accumulation of more; but even our best-established conclusions we hold subject to revision, at least as regards their theoretical expression. Even on the strength of experience we do not undertake to dictate as to what must be, for all experience is, we are aware, imperfect. We know in part, and therefore, when we are wise, we prophesy but in part. To revert for a moment to the science of astronomy, it may be said that we find there an unending series of lessons against *a priori* and absolute views. The planets are not perfect spheres; their orbits are not perfect circles, nor do they perfectly retain their form; their rates of movement are not uniform; their inclinations to the planes in which they move undergo constant changes. It might be supposed beforehand that they would all be developed on the same plan and in some regular order of gradation; but no, they increase in size from Mercury to the earth; then we have the moon (which is strictly a planet) of much inferior size; then Mars, much larger than the moon, but much smaller than the earth; then the fragmentary asteroids; then the giant Jupiter; then Saturn and Uranus successively smaller; and finally Neptune, larger than Uranus but smaller than Saturn. Again, as if to show a unique example of the way in which rings were thrown off from the original nebula, Saturn alone of all the planets is surrounded by rings which, in some way, managed to preserve their equilibrium as rings instead of being rolled together by gravitation into spheres. The solar system as a whole seems to speak to us in commanding tones and say, "When the laws and phenomena of Nature are concerned, don't assume to know what ought to be, but find out what is." On this line of the patient study of Nature all the victories of modern science, we might almost say of modern civilization, have been won.

Science is now of age and can take care of itself, but we have not to look back very far in the history of the world in order to come to the time when it had to ask the permission of Theology and so-called Philosophy for every step it took, and when frequently its progress was absolutely barred by some arbitrary mandate. In our own day even, what opprobrium has been heaped upon geologists like Lyell, and biologists like Darwin, simply because their conclusions threatened to disturb those in which the orthodox world, on wholly insufficient evidence, had been pleased to settle down! Henceforth Science will brook no dictation. She will not herself dictate to Nature, and she will suffer no arbitrary authority to dictate to her. What is scientifically true will be determined by evidence industriously gathered, carefully sifted, and cautiously interpreted; and the world will reap the benefit of the principles thus established in ever new additions to the comforts and refinements of life. Still more important, however, it may be hoped, will the progress of scientific thought prove in the intellectual and moral sphere. We want what we have never had as yet, but what the labors of that truly great philosopher Herbert Spencer have at least in part provided for us, a true science of life—that is to say, a scientific treatment of the duties of life and the means of happiness. But meanwhile much advantage will result from the gradual spread of scientific methods of thought—methods which incline to caution, to a careful scrutiny of causes and consequences, in the sphere of social action. Here-

tofore wisdom has been largely won through suffering; but we may hope that, with the wider establishment and recognition of sound principles of conduct, this will more and more cease to be the case. There does not seem any very good reason why men might not be taught to love right conduct just as they may be, and are, taught to prefer temperate and wholesome to intemperate and unwholesome eating and drinking. To tell the truth an advance of science is more wanted to-day in the sphere of conduct than in the mechanical arts. We could get on very well for the next quarter of a century without traveling any faster, or without any further cheapening of cotton goods; but every day we feel directly or indirectly the need of greater wisdom in the conduct of life; for daily we suffer either through our own errors or those of others. Ancient codes of ethics are very well—some of them at least—as far as they go; but it will be a good day for the world when it is universally recognized that the true canons of conduct are deducible by sound reasonings upon the facts of life and the relations of individuals, and that, so deduced, they have the highest authority that any moral code can possess.

A SCIENTIST, BUT NOT A PHILOSOPHER.

Among the papers contributed to the World's Congress of Religions was one by Sir William Dawson, of Montreal, entitled Religio Scientiæ (the Religion of Science). This eminent geologist never loses an opportunity of attacking the doctrine of evolution, and it is not surprising, therefore, that he should have done so on this occasion. No evidence has ever been afforded, however, that Sir William Dawson has taken proper pains to ascertain what evolution, as understood and taught by the leading believers in the doctrine, means. Speaking of man's moral nature, he says: "On this point a strange confusion, produced apparently by the doctrine of evolution, seems to have affected some scientific thinkers, who seek to read back moral ideas into the history of the world at a time when no mundane moral agent is known to have been in existence. They forget that it is no more immoral for a wolf to eat a lamb than for a lamb to eat grass." Now, it would be simply impossible for any one who had read even so brief a treatise as Spencer's Data of Ethics with any attention to have made such a remark. Let any one to whom that treatise is in the least familiar try to imagine Spencer forgetting that "it is no more immoral for a wolf to eat a lamb than for a lamb to eat grass"! A man with Sir William Dawson's reputation should really not commit himself in this way. Not only is there not one word in Spencer's writings to indicate that he thinks it immoral for a wolf to eat a lamb, but his whole method of treating the subject of the development of morality shows that he utterly repudiates such a view. What Spencer does attempt to do is to prove that the conduct we now call moral must be regarded as a development from conduct to which it is impossible to apply the term. He traces for us in the most careful manner every stage of the process; and if Sir William Dawson would undertake to point out where the line of succession fails, or, to express it otherwise, where the evolution of one stage from that immediately preceding it has been incorrectly assumed, he would then be grappling seriously with the ethical side of the doctrine of evolution. To do this, however, he would have to study Mr. Spencer's Principles of Ethics with careful attention, and this would probably not be agreeable to him. It would be easy to note other points in Sir William's address to which, from a scientific point of view, exception might be taken. Our purpose, however, on the present occasion is sufficiently served by showing that this really able geologist allows

himself to speak on philosophical subjects with altogether too slender an equipment of necessary knowledge.

LITERARY NOTICES.

THE HISTORY AND THEORY OF MONEY. By SIDNEY SHERWOOD, with Addresses by Dr. WILLIAM PEPPER and others. Philadelphia: J. B. Lippincott Company. Pp. 413. Price, $2.

THE American people has heard more about the theory of money during the past summer than in a long time before. Much that has been said has been erroneous, and, unfortunately, the error has often been put forth so speciously that many of those who have not given the subject of finance serious study have mistaken the false for the true. During the early months of 1892, when the subject of money was also attracting considerable attention, a series of lectures was delivered in Philadelphia, under the auspices of the American Society for the Extension of University Teaching, and the patronage of the bankers of Philadelphia. These lectures were given by Dr. Sherwood, of the Wharton School of Finance and Economy, and, with certain supplementary matter, constitute the volume before us. The twelve lectures are evenly divided between history and theory; under the former head the principal topics are coinage, past fluctuations in the supply of the coin metals, the development of credit, the history of the Bank of England, and the history of American currency. The first lecture on theories is also historical, while the remaining five are devoted wholly to monetary theories now current. Dr. Sherwood affirms that the practical law of value of money is the law of demand and supply. Governments can, within narrow limits, make money more or less desirable and more or less plenty, thus affecting its value. He presents the argument both for and against a large volume of currency, and then sets forth certain important facts that bear upon this matter. Paper money he describes as a promise to pay. In treating of banks of various kinds he states that there is a growing tendency to divorce note-issue from the deposit and discount functions of banks; that the latter functions are constantly becoming more important, while there are tendencies both for and against the extension of the former. The eleventh lecture deals with the monetary question of greatest current interest—the Battle of the Standards, or monometallism *versus* bimetallism. Dr. Sherwood gives the arguments of both parties in the controversy, and states his conviction that bimetallism based on an agreement of the chief commercial nations would be advantageous, but attempted by one nation alone would be disastrous. France maintained it only so long as certain accidental conditions existed. The policy of the United States under the Sherman law is not bimetallism. The subject of the closing lecture—monetary panics—is also a timely one. The lecturer points out seven causes of panics, and states the measures taken by financial institutions for allaying them. Each of the lectures was followed by a discussion, which is reported. Appended to the volume are a syllabus of the lectures and a list of books for reading. Addresses made by Dr. William Pepper, Mr. William H. Rhawn, and others, at the opening and closing of the course, are also included.

BRIEF GUIDE TO THE COMMONER BUTTERFLIES OF THE NORTHERN UNITED STATES AND CANADA. By SAMUEL HUBBARD SCUDDER. New York: Henry Holt & Co. Pp. 206. Price, $1.25.

THE LIFE OF A BUTTERFLY. By S. H. SCUDDER. New York: Henry Holt & Co. Pp. 186. Price, $1.

THE former of these small volumes is a manual for amateur collectors. The author has aimed to guard against alarming the beginner by its size, and to give quite full life-histories of the butterflies that are included in it. It is described further in his own words as follows: "I have accordingly selected the butterflies—less than a hundred of them—which would almost surely be met with by any industrious collector in the course of a year's or two years' work in the more populous Northern States and in Canada, and have here treated them as if they were the only ones found there. I have omitted many species which are common enough in certain restricted localities (such, for instance, as our White Mountain butterfly), and included only those which are common over wide areas. As the earlier stages of these insects are just as varied, as inter-

esting, and as important as the perfect stage, descriptions are given of these under the guidance of the same principle." The work opens with a short introduction to the general study of butterflies, which is followed by keys to the various groups, based respectively on the perfect butterfly, the caterpillar, and the chrysalis. The body of the work consists of concise descriptions arranged systematically, each comprising first a description of the butterfly, the caterpillar, and the chrysalis, then some account of the eggs and habits of the species. An appendix furnishes instructions for collecting, rearing, preserving, and studying, with cuts of apparatus.

In The Life of a Butterfly, Mr. Scudder has described one of the most conspicuous American butterflies—the large orange and black milkweed butterfly—and at the same time he has, by introducing comparisons, given some account of the lives of the other members of its tribe. The several habits of the chosen type are also used to illustrate such general scientific topics as the struggle for existence, mimicry, distribution, classification, etc. Four plates, showing the type insect and its important parts, are given.

GENERAL GREENE. By FRANCIS VINTON GREENE. Great Commanders Series. New York: D. Appleton & Co. Pp. 332. Price, $1.50.

SOME splendid fighters have come of Quaker stock, and Nathanael Greene was a notable one of these. His comparatively short life was a most valuable one to this country, and to-day his statue stands with that of Roger Williams to represent Rhode Island in the Capitol at Washington. His life up to thirty-three years of age was uneventful. Then the Revolution broke out, and the Assembly of his colony elected him brigadier general to command the Rhode Island militia. The choice was amply justified by Greene's career, first as a thorough organizer in camp near Boston, then as the friend and trusted subordinate of Washington in the operations about New York and Philadelphia, as quartermaster general, and most of all as the strategist, ever active and vigilant, who manœuvred the British out of the Carolinas. The volume before us gives a vivid and detailed account of his part in the struggle for independence. The descriptions of battles are clear and precise and all important ones are illustrated with maps. An engraving from the portrait of Greene by Charles Wilson Peale forms the frontispiece of the volume.

GEOLOGY. By A. J. JUKES-BROWNE. New York: Macmillan & Co. Pp. 248. Price, $1.

THIS is one of the volumes of Whittaker's Library of Popular Science, and its simple style amply justifies its appearance in such a series. It is a small book, containing only the information that would be desired by an intelligent person who did not care to make a study of the subject. Its twenty-one short chapters are divided into three groups: the first telling how rocks are made, and what they are made of; the second telling how the rocks were brought into the positions they now occupy; and the last describing the rocks of different ages, and the fossils which serve to identify them. There are ninety-four illustrations.

A HISTORY OF IRELAND IN THE EIGHTEENTH CENTURY. By W. E. H. LECKY. New York: D. Appleton & Co. Five volumes. Price, $5.

IN this work Mr. Lecky develops a profoundly interesting chronicle. Not only does it present much that is novel to those whose ideas of the subject have filtered through English media, but it reveals the forces which have aided in the evolution of Irish character.

The typical traits of the Irish are often carelessly ascribed to racial differences. The influence of the Celtic element is not easily traced and is apt to be overestimated. What are termed distinctively Irish evils characterize chiefly the counties settled by Englishmen. Religion has been a more potent factor in modification, while the climate and situation of the country have had an important share in the formative process.

The suppression of her industries contributed largely to the downfall of the nation. The policy of England, however, was essentially the same toward Scotland and America, but Ireland was for various causes more completely in her grasp. It is difficult to read unmoved the struggles of this unfor-

tunate people. Not only was their land confiscated, all commerce and manufacture legally restricted, their religion made a crime, but premiums were put upon bribery and treachery. The feeling in England was carried to such an extreme that petitions were presented to prohibit Irishmen from catching herrings, because they might forestall English markets! According to Burke, "the Irish were treated as a race of savages who were a disgrace to human nature itself," and even the poet Spenser advocated their subjection by systematic starvation. The object of English rule seemed at first to wipe out the Irish race rather than their religion; later, it assumed the phase of a war of creeds.

It is shown by Mr. Lecky that the Irish were naturally tolerant. They harbored Quakers and Huguenots, sheltered Protestant clergymen, and did not indulge in the burning of witches. The English, on the contrary, were relentless persecutors, and although there was no summary destruction of Papists in Ireland, such as there had been of Protestants in Spain, yet the results of legislation were further reaching and more pernicious. "The law did not suppose any such person to exist as an Irish Roman Catholic." Every office and profession was closed to him; it was even a penal offense to pick up the crumbs of learning as an usher in a school. Land he could not buy, nor own a horse over the value of five pounds. He could not appoint a guardian for his own child, and if he married a Protestant, the ceremony was null and the priest who performed it could be hanged. The degradation of the Irish by this penal code was unparalleled, since it affected not a minority but three fourths of the population and was in force nearly a century. A perusal of the laws in the light of the present day is enough to make one blush for English ancestry. Judged even by the intolerance of the age, they were excessive and short-sighted, and form an indelible blot upon English government. The disputed character of Irish history necessitates frequent reference to original materials; these include the correspondence and records of the English and Irish Governments and a vast number of private papers and letters. The reader is thus enabled to judge the truth for himself, and, far from finding the narrative a dull one, is almost persuaded that he is in the current of events.

The limits of this work do not correspond to those of the History of England, previously issued. They include the rebellion of 1798, the legislative union of 1800, and the events of the two succeeding years, as properly belonging to the same epoch.

THE PHYSIOLOGY OF THE SENSES. By JOHN GRAY MCKENDRICK, M. D., and WILLIAM SNODGRASS, M. B. New York: Charles Scribner's Sons. Pp. 318. Price, $1.50 net.

IT is the aim of this book, which is one of the series issued under the name of University Extension Manuals, to give a succinct account of the functions of the organs of sense in man and the higher animals. The authors have refrained from discussing with fullness of detail either the comparative physiology of the senses or the numerous interesting questions of a psychological character that are connected with the study of the sensory mechanisms. The volume has been written so as to be readily understood even by those who have not made physiology a special subject of study. Some comparatively simple experiments have been given, by which the reader may test certain of the statements for himself. The last chapter is of a speculative character, being an attempt to elucidate the nature of the physiological basis of sensation. The volume is illustrated with one hundred and twenty-seven figures.

BRITISH FOREST TREES AND THEIR SYLVICULTURAL CHARACTERISTICS AND TREATMENT. By JOHN NISBET, D. Œc. New York: Macmillan & Co. Pp. 352. Price, $2.50.

ONE more evidence of the growing attention that is being paid to forestry is furnished by the appearance of this work. It is devoted to what may be called the larger considerations of sylviculture, such as the choice of kinds of trees for plantations, the mixing of different kinds, so that they will help and protect each other, the proper density of forests, underplanting, etc., details of such matters as sowing, planting, and tending being omitted. The greater part of the volume is devoted to special considerations regarding the growth of individual

species of British forest trees. Among those classed as minor species not usually forming pure forests in Britain are five conifers introduced from North America. Something is told also in regard to the yew, juniper, hazel, alder, buckthorn, and hawthorn among useful shrubs.

LECTURE NOTES ON THEORETICAL CHEMISTRY. By F. G. WIECHMANN. New York: John Wiley & Sons. Pp. 225.

A LARGE body of notes, corresponding to an extended course of lectures, is given in this book. Many of the facts, laws, and processes which it includes are stated with much fullness and are accompanied with illustrative examples. As indicated by the title, the work is confined to theoretical chemistry, and much of the history of chemical theory is included in it. A chapter is given to solutions in which the recent work on that subject finds a place. Thermo-chemistry receives due attention, and there are short chapters on photo-chemistry and electro-chemistry. Considerable prominence has been given to stoichiometry, but for problems in this subject students are referred to special manuals. The author is instructor in chemical physics and chemical philosophy at the School of Mines, Columbia College.

THE BIRTH AND DEVELOPMENT OF ORNAMENT. By F. EDWARD HULME, F. L. S., F. S. A. New York: Macmillan & Co., 1893. Pp. 340. Price, $1.50.

THIS book is an attempt to put into small compass and cheap form a general view of the origin and growth of the use of ornament. The opening paragraph follows: "The Birth of Ornament! Countless centuries before man appeared upon the earth, the Creator of the universe had gazed upon the work of his hands, and declared that all had reached his lofty ideal." Certainly the author can not be accused of too modern a starting point, and he further on puts this beyond question. "Hence we claim for our subject nothing short of infinite antiquity, nothing less than divine authority." The first chapter deals with the value of a knowledge of past ornamentation, the study of principles, and various other general matters. Chapter II really opens the subject, with a consideration of Egyptian, Assyrian, Babylonian, and Phœnician art. Chapter III deals with Greek and Roman art Chapter IV, division of the Roman Empire: Byzantine, Romanesque, and Early English Art; Chapter V, Causes of the Decay of Gothic Art, and the Renaissance; and Chapter VI, The Art of Islam, Persian, Indian, Chinese, Japanese, Mexican, Peruvian, and, finally, Art among the North American Indians and the Primitive Savages. The work seems to be the result of a large amount of labor and time. It is very well illustrated with examples from the various periods, and abounds in quotations from such authorities as Sir Joshua Reynolds, Guizot, Ruskin, and Wilkinson. It contains a useful index.

A DICTIONARY OF APPLIED CHEMISTRY. By T. E. THORPE, D. Sc., F. R. S., assisted by Eminent Contributors. In Three Volumes. Vol. III. O–Z. London and New York: Longmans, Green & Co. Pp. 1056. Price, $20.

WE congratulate the editor and the publishers upon the completion of this valuable work. So many subjects requiring extended treatment fall within the latter part of the alphabet that the concluding volume has grown far beyond the size of the other two, and its price has been increased by five dollars. The article on Sulphuric Acid occupies sixty pages, and treats fully each detail of the process of manufacture. Sixteen cuts, showing brimstone burners, steam jet pipes, Gay-Lussac and Glover towers, and other apparatus are given. Another subject demanding large space is the making of sodium carbonate, which is described with like fullness. The making of other compounds of sodium and the extraction of the metal itself also receive due attention. Under the head of Silver the extraction of that metal is described, and under Zinc we find the methods of extracting the metal and the composition of its alloys. The article on Water, contributed by Prof. Percy F. Frankland, is characterized by a large number of results of analyses of waters from sources of various geological characters and from various local supplies—mainly in the British Isles. The composition of many saline and other mineral waters is given also. Modes of purifying water for drinking and for industrial purposes are described, together with a process of chemical analysis. Prof. Frankland also gives a special section on the bacteriol-

ogy of water, and refers inquirers to half a page of authorities. Among the organic substances treated in this volume are the oils, paraffin, petroleum, starch, and sugar. The Vegeto-alkaloids, grouped under this head, are also found here. The Triphenylmethane Coloring Matters are another important group of organic substances treated in the present volume, the author of the article being Prof. Otto N. Witt, of Berlin. Alfred H. Allen, author of the Commercial Organic Analysis, contributes the article on Fixed Oils and Fats; Prof. W. A. Tilden, those on the Essential Oils, Terpenes, and Resin; the one on Sugar is by Messrs. J. A. R. and B. E. R. Newlands; that on Russian Petroleum is by Boverton Redwood; and that on American Petroleum by Prof. S. P. Sadtler, of the University of Pennsylvania. Among the more purely scientific articles are those on Specific Gravity, Solution, and Spectrum Analysis; while others whose technological character are more marked are Paper, Pottery and Porcelain (by William Burton, Esq., of the Wedgwood Works), Photography, Soap, Tea, and Wine. The contributions of the editor (unsigned articles) are many and important. When so much chemical knowledge is spread before us, perhaps we ought not to expect Prof. Thorpe to know what Americans mean by saleratus, or even the current spelling of the word (p. 364); and it is still less material that he allows his contributor, John Heron, Esq., to annex Long Island to New Jersey (p. 579).

A GUIDE TO STEREOCHEMISTRY. With an Appendix: Models for Use in teaching Organic Chemistry. By ARNOLD EILOART, Ph. D., B. Sc. New York: Alexander Wilson, 26 Delancey Street, Agent. Price, $1 net; postage free.

THE scope and purpose of this book may be best indicated by the following quotation from the author's preface:

"Although no new branch of chemistry is found more interesting by chemists and students than that which treats of the arrangement of atoms in space, so that lectures on the subject are everywhere welcome, yet it has been difficult to give guidance and permanence to this interest. . . . It seemed desirable in attempting to supply such a book to make it as compact as possible without stripping the subject of the charm so natural to it. In this Guide, therefore, established facts have been promptly accepted as such. . . . Living issues appropriate the pages thus gained, so that more than the usual proportion of space is occupied by the later and more daring developments of stereochemistry; the theories concerning the space-relations of nitrogen are a case in point. At the same time especial care has been taken to notice the criticisms of those hostile to such innovations."

It should be added that this work, while it may be used as a text-book by students, will also be read as a critical and historical review of the subject.

The American Book Company adds Shakespeare's *Merchant of Venice* to its series of English Classics for Schools. An account of the sources whence the play was derived, a notice of the occasion on which it was written, suggesting that it was designed to take advantage of current sensational events, and an analysis, are given in the introduction.

The *Letters from Queensland* (Australia), reprinted from the special correspondence of the London Times by Macmillan & Co., contains, besides sketches of travel and scenery and incidental observations of Chinese and Kanaka labor, valuable information and statistics about the sugar industry and mineral wealth of the colony, cattle and sheep raising, and a political chapter on the Separation Question, or the question of the division of the colony by the separation of North Queensland.

Moses or Darwin? A School Problem for all Friends of Truth and Progress, is the title of three papers on Evolution and Darwinianism which were originally delivered as lectures by the author, Dr. *Arnold Dodel*, at Zurich and St. Gall, Switzerland. Their immediate purpose was to direct the attention of the public "to the calamitous gulf lying between the higher and the common schools"—which he further describes by the words "Truth for the few" (higher school pupils, to whom the scientific doctrines of evolution are taught) and "Errors for the many" (lower school pupils, who are taught "the Mosaic myth"). The translator and American editor, Frederick W. Dodel, furnishes a preface, in which is a disquisition on School

Reform in the West, the burden of which is the installation of science and the elimination of all religious teaching in all the schools. (The Commonwealth Company, Boston.)

The character of the Essays included by Mr. *Henry Smith* under the general title of *Religion of the Brain* is indicated by the frontispiece, which pictures an ivy-grown tree with the motto, "The Ivy has nearly killed the tree, Theology has all but destroyed religion. Science will kill Theology, then Religion will revive." Submitting to theological teachings during half of his life, he professes to have found them barren. Then he turned to science, and, while it took from him the hope of heaven, it taught him how to make this life happy; it took from him theology, and gave him natural religion. He sets forth in this book how he accepts the teaching of science and declines that of theology. (Watts & Co., London. Price, 2*s.* 6*d.*)

Karl Heinzen, the author of a volume on *The Rights of Women and the Sexual Relations*, published by Benjamin R. Tucker, Boston, is described by Karl Schmemann, editor of this present edition, as "one of the most enlightened and humanitarian spirits of our time, whose libertarian and reformatory labors were not limited to his German fatherland and our republic, but extended to the entire civilized world by their unique and masterful many-sidedness." The author advocates, with great freedom and little reserve, the complete emancipation and independence of woman, with "liberty to choose her companion and liberty to change."

Instead of a Book is published by the author, *Benjamin R. Tucker*, because, he says, he was "too busy to write one"; that is, to give orderly arrangement, finish, symmetry, and due subordination to his thoughts on the cause he champions. He has been for twelve years editor of a journal called Liberty, in which he has expounded the principles of "Philosophical Anarchism." Pending the arrival of the man having time, means, and ability to produce the book that is desired in maintenance of this cause, he has put forth "as a makeshift" a partial collection of his writings for his journal. The volume opens with a paper on State Socialism and Anarchism, which represents, in a way, a summary of the entire scope of the work. In the sections, or groups of essays following this, the fundamental principles of human association (as he regards them) are dealt with; applied to the two great economic factors, money and land; the "authoritarian social principles that go counter to them" are dealt with; and the methods by which the championed principles can be realized are discussed. Other articles, less subject to classification, follow. While the work is highly objectionable from the conservative point of view, it is not at all wanting in vigor and earnestness. ($1.)

In preparing his *Standard Arithmetic* for schools and academies, President *William J. Milne* of the Normal College at Albany, has aimed to secure together in the student skill in numerical computations and a proper understanding of the reasons for the steps in the explanation of processes and the solution of problems. Either can be acquired without the other, but the student will not then be a full arithmetician, while with both he is qualified for any work. The book, therefore, contains examples to promote accuracy and rapidity, and exercises to train the analytical powers and develop the reasoning faculties. Business methods of computation are preferred to the processes of the schools. (American Book Company.)

Mr. *R. Lachlan's Elementary Treatise on Modern Pure Geometry*, and the *Elementary Treatise on Pure Geometry* of Mr. J. W. Russell, cover substantially the same ground in very similar manners. Pure geometry is defined in the new regulations for the Cambridge Tripos as "namely, Euclid; simple properties of lines and circles; inversion; the elementary properties of conic sections treated geometrically, not excluding the method of projections; reciprocation; harmonic properties; curvature." Mr. Lachlan has brought together in his treatise all the important propositions—bearing on the simple properties of lines and circles—that might fairly be considered within the limits of this regulation; and has at the same time endeavored to treat every branch of the subject as completely as possible, in order to attract a larger number of students to the science. Mr. Russell has attempted in his treatise to bring together all the well-known theorems and examples connected with harmonics, anharmonics, involution, projection (including

homology), and reciprocation. In order to avoid the difficulty of framing a general geometrical theory of imaginary points and lines, the principle of continuity is appealed to. The properties of circular points and circular lines are then discussed, and applied to the theory of the foci of conics. This work is also well furnished with examples. (Macmillan & Co. Price, $4.25 and $2.60.)

The *Primary Lessons* and the *Advanced Lessons in Human Physiology*, by Prof. *Oliver P. Jenkins*, are successive volumes in the Indiana State series of common-school textbooks. The author insists that the books be used only as a guide to the study of the human body, and not as the object to be studied. "If this or any other elementary book in physiology is used simply as a book to be learned and recited, the time spent on it is worse than wasted." The author shows that many parts of the body can be put directly under study and their operations carefully observed and analyzed, while the lower animals can furnish the rest of the illustrations. The body should also be observed in action. Charts and drawings have their place in the teaching, but "they should come after the objects and never before, and certainly should not stand for them." In the second book of the series—*Advanced Lessons*—directions are introduced for the practical demonstration of many anatomical and physiological facts. Recognizing the change that has come in recent years over the tone and spirit of physiological thought and discussion, the author has endeavored to infuse enough of this spirit into his work "to introduce even the young student into its influence." (Indiana Schoolbook Company, Indianapolis.)

A *Student's Manual of a Laboratory Course in Physical Measurements*, by *Wallace Clement Sabine*, is a guide to experiments. It was primarily written for one of the Harvard courses in physics, and the experiments detailed in it are based upon those performed in that course. It has been given the form of an abstract of the daily lectures preceding the laboratory work and describing the experiments to be performed, and is intentionally condensed. Efforts are made to explain all the corrections to be applied, and to call attention to all the precautions which should be taken in the accurate and proper performance of the experiments. On the other hand, in the majority of cases, the description is purposely not such as will admit of a mechanical and unintelligent interpretation. (Boston: Ginn & Co.)

The second part of *Jane H. Newell's Reader in Botany* contains selections for reading, adapted from well-known authors, on flower and fruit. In it Christian Conrad Sprengel is represented by passages on Cross-Fertilization and Fertilization of Tropæolum, Darwin in Cross-Fertilization, Heterostyled Flowers, and the Habits of Insects in Relation to Flowers, writers in the German *Pflanzenleben* in The Protection of Pollen, The Dissemination of Pollen by the Wind, and The Color of Flowers as a Means of attracting Insects; Wallace in Attractive and Protective Colors of Fruits; Gray in Fertilization of Orchids; Grant Allen and Byron D. Halsted in Weeds; F. L. Sargent in The Common Dandelion; Sir John Lubbock in Habits of Insects in Relation to Flowers; Miss Buckley in Epochs in the History of Botany; and four papers have no names attached. (Boston: Ginn & Co.)

The Orum System of Voice Education, for reading and conversation, recitation, dramatic expression, and Bible reading, by Julia A. Orum, is based on the system of James Fennell, as transmitted through his pupil, L. G. White, and Mr. White's pupil, James B. Roberts. The author has made its illustration and establishment her special work for sixteen years. The book is a transcription of her method of instruction in schools and classes which include children and men and women of various vocations. It is based upon physiological principles, and begins with the elucidation of the elemental functions of the body in the expression of sentences. (Published by the author at Philadelphia.)

The *Manual of Current Shorthand*—orthographic and phonetic—of Mr. *Henry Sweet* is intended to supply the want of a system of writing shorter and more compact than longhand, and at the same time not less distinct and legible. None of the systems most in use at the present time, the author affirms, fully meet these requirements, because they sacrifice efficiency to brevity. The present system is on a script basis instead of a geometrical one, like Pitman's—that is, is formed on its model of ordinary longhand, reduced

to its simplest elements; it provides for the vowels, and is on an alphabetic and syllabic basis. (Macmillan & Co., $1.25.)

The seventeenth monograph of the Geological Survey is *The Flora of the Dakota Group*, a work on fossil botany by the late *Leo Lesquereux* (Geological Survey, $1.10). The specimens from which the descriptions in this work were written are mostly in the Museum of Comparative Zoölogy at Cambridge, the museum of the University of Kansas, and the private cabinet of Mr. R. D. Lacoe, of Pittston, Pa. This was the last production of its author, and the chief events of his life are appropriately set forth in the editor's preface.

A monograph on the *Gasteropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey*, by *Robert Parr Whitfield*, is the eighteenth in the series of the Geological Survey, and forms also a part of the report on the Survey of the State of New Jersey. The material for this report was very meager, the gasteropods being represented in the several formations only by casts and the cephalopods largely by fragments. Fifty plates, each bearing from one to thirty figures, illustrate the text.

The United States Geological Survey has issued *A Dakota-English Dictionary*, by *Stephen Return Riggs*, a quarto volume of 665 pages. The author, who died in 1883, was a student of the language for missionary use for over thirty years, having prepared a grammar and dictionary that was published by the Smithsonian Institution in 1852. The present volume has been edited by James Owen Dorsey.

In the *Report of the Commissioner of Education for 1889–'90* it is shown that the property used for common schools had reached the value of $350,000,000, an average increase of $10,000,000 a year since 1870. In the same period the school attendance in the South Atlantic States had risen from six to twenty-two per cent of the whole population, and in the South Central States from seven and a half to twenty-three and a half per cent. The enrollment for the whole country is twenty-three per cent. This is a better showing than that of any other nation except Saxony. But many European states have a much longer yearly session than we have. Here, says the commissioner, is the place to show improvement in future years. Among the subjects on which special reports are presented are the educational congresses held in Paris in 1889, education in Scotland, the higher schools of Prussia and the school conference of 1890, temperance instruction, and the curricula of professional schools. Numerous other topics receive attention also, and there are the usual statistics.

PUBLICATIONS RECEIVED.

Aëronautics. M. N. Forney, Editor and Proprietor. New York: American Engineering and Railroad Journal. Monthly. Pp. 16. 10 cents. $1 a year.

Arnold, Thomas K. First and Second Latin Book. Pp. 416.—Latin Prose Composition. American Book Company. Pp. 415. $1 each.

Bardeen, C. W. History of Educational Journalism in the State of New York. Syracuse, N. Y.: C. W. Bardeen. Pp. 45. 10 cents.

Bedell, Frederick, and Crehore, A. C. Alternating Currents. New York: W. J. Johnston Co., limited. Pp. 325.

Benedict, James E. West African Crustaceans. Washington: Smithsonian Institution. Pp. 10.

Bennet, C. W. History of the Philosophy of Pedagogics. Syracuse, N. Y.: C. W. Bardeen. Pp. 43. 50 cents.

Bowen Cooke, C. J. British Locomotives. New York: Macmillan & Co. Pp. 376. $3.

Bradford, E. G. Search Lights and Guide Lines (Man and Nature, etc.). New York: Fowler & Wells Co. Pp. 108.

Brooklyn Institute of Arts and Sciences. Prospectus for 1893–'94. Pp. 55.

Brown, Marshall. Bulls and Blunders. Chicago: S. C. Griggs & Co. Pp. 304. $1.

Calvin, Samuel, State Geologist, and Assistants. Iowa Geological Survey, 1892. Volume I. Des Moines. Pp. 472.

Carter, Oscar, C. S. Artesian Wells. Pp. 9.

Carus, Dr. Paul. Our Need of Philosophy. Pp. 14.—The Religion of Science. Pp. 108. 25 cents.

Cox, Frank P. Continuous-current Dynamos and Motors. New York: W. J. Johnston Co., limited. Pp. 271.

Dall, William Healey. A Subtropical Miocene Fauna in Arctic Siberia. United States National Museum. Pp. 10, with Plate.

Davy, R. B., M. D., Olema, Cal. Evolution and Involution of the Special Senses. Pp. 10.

De Quincey, Thomas. Joan of Arc and The English Mail Coach. Edited, etc., by J. M. Hart. New York: Henry Holt & Co. Pp. 128.

Drake, N. F., and Thompson, R. A. Report on the Colorado Coal Field of Texas. Austin. Pp. 136, with Maps.

Fontaine, William M. Fossil Plants from the Trinity Division, Texas. United States National Museum. Pp. 26, with Plates.

Gould, George M., M. D., Philadelphia. The Duty of the Community to Medical Science. Pp. 12.—A Temporary Change in the Axis of Astigmatism. P. 1.—The Meaning and the Method of Life, reviewed by Josiah Royce. Pp. 7.—The Medical Press. Pp. 12.—The Spelling of some Medical Words. Pp. 8.—The Pernicious Influence of Albinism on the Eye. Pp. 10.—A New Illustrated Dictionary of Medicine, Biology, and Collateral Sciences. Specimen pages.

Hart, Ernest. The Profession, the Public, and the Code. Address before the Pan-American Medical Congress.

Haug, W. P. Blind Crayfishes of Indiana, etc. United States National Museum. Pp. 4, with Plate.

Hayes, M. Horace. The Points of the Horse. New York: Macmillan & Co. Pp. 379, with Plates. $10.50.

Hill, David J. Genetic Philosophy. New York: Macmillan & Co. Pp. 382.

Hill, Robert T. Palæontology of the Cretaceous Fossils of Texas, etc. Biological Society of Washington. Pp. 12, with Plates.

Jenner, Sir William. Lectures and Essays on Fevers and Diphtheria, 1849 to 1879. New York: Macmillan & Co. Pp. 581.

Killeman, W. A. Photographing Certain Natural Objects without a Camera. Pp. 2.—Experiments in Germination of Treated Seed. Pp. 5.—Bibliography of Ohio Botany. Pp. 22.—Killeman, W. A., and Selby, Aug. D. Analytical Synopsis of the Groups of Fungi. Pp. 8.

Kirk, Hyland C. The Revolt of the Brutes. New York: C. T. Dillingham & Co. Pp. 123. 50 cents.

Leffmann, Henry, and Beam, William. Analysis of Milk and Milk Products. Philadelphia: P. Blakiston, Son & Co. Pp. 92. $1.

Leo XIII. Encyclical on the Condition of Labor. Boston: Pilot Publishing Co. Pp. 16.

Loewinson-Lessing, F., and others. Tables for the Determination of Rock-forming Minerals. New York: Macmillan & Co. Pp. 55. $1.25.

McAulay, A. Utility of Quaternions in Physics. New York: Macmillan & Co. Pp. 107. $1.60.

McKinley, William. Speeches and Addresses. New York: D. Appleton & Co. Pp. 664. $2.

Michigan Mining School. Reports of the Director. Pp. 102.

Monroe, W. S. The Educational Labors of Henry Barnard. Syracuse, N. Y.: C. W. Bardeen. Pp. 35. 50 cents.

Müller, F. Max. Three Introductory Lectures on the Science of Thought. Chicago: Open Court Publishing Co. Pp. 125. 25 cents.

Munro, J. C. Elementary Text-book of Commercial Law. New York: Macmillam & Co. Pp. 191. 90 cents.

Newton, Alfred, and Gadow, Hans, etc. A Dictionary of Birds. Part II. Ga-Moa. New York: Macmillan & Co. Pp. 212.

New York Academy of Sciences. Transactions, 1892-'93. Pp. about 300.

Nutting, C. C. President's Address, Iowa Academy of Sciences. Pp. 5.—Report of Committee on State Fauna. Pp. 3.—Significance of the Concealed Crests of Fly-catchers. Pp. 5.

Peck, James I. Pteropods and Heteropods collected by the Steamer Albatross during the Voyage from Norfolk, Va., to San Francisco, Cal., 1887-'88. United States National Museum. Pp. 17, with Plates.

Pilling, James Constantine. Bibliography of the Chinookian Languages. United States Bureau of Ethnology. Pp. 81.

Powell, J. W. Report of the Bureau of Ethnology, 1886-'87. Washington. Pp. 298, with Plates.

Preece, William H., and Stubbs, Arthur J. A Manual of Telephony. New York: Macmillan & Co. Pp. 508. $4.50.

Prosser, C. S. The Upper Hamilton and Portage Stages of Central and Eastern New York. Pp. 18.

Rein, Prof W. Outlines of Pedagogics. Syracuse, N. Y.: C. W. Bardeen. Pp. 199. $1.25.

Richmond, Charles W. On a Collection of Birds from Eastern Nicaragua and Rio Frio, Costa Rica, etc. United States National Museum. Pp. 54.

Romanes, G. J. An Examination of Weismannism. Chicago: Open Court Publishing Co. Pp. 221. $1.

Roscoe, Sir Henry, and Lunt, Joseph. Inorganic Chemistry for Beginners. New York: Macmillan & Co. Pp. 245. 75 cents.

Sanford, Henry R. The Limited Speller. Syracuse, N. Y.: C. W. Bardeen. Pp. 104. 35 cents.

Saunders, Frederick, Editor. Addresses commemorative of the American Centennial and of the Discovery. New York: E. B. Treat. Pp. 1041. $3.50.

Scientific Alliance of New York. Third Annual Directory. Pp. 40.

Scott, Sir Walter. The Lady of the Lake. American Book Company. Pp. 192. 35 cents.

Siemens, Werner von. Personal Recollections. New York: D. Appleton & Co. Pp. 406. $5.

Smith, John B. Catalogue of the Lepidopterous Superfamily Noctuidæ found in Boreal America. United States National Museum. Pp. 424.

Speakman, Thomas H. Divisions in the Society of Friends. Philadelphia: J. B. Lippincott Co. Pp. 112.

Stearns, Robert E. C. Mollusk Fauna of the Galapagos Islands. Pp. 96, with Plates.—Rare or Little-known Mollusks from the West Coast of North and South America. Pp. 12, with Plate.—Molluscan Species collected in West Africa, 1889-'90. Pp. 20.

Todhunter, Isaac, and Pearson, Karl. A History of the Theory of Elasticity and of the Strength of Materials from Galilei to the Present Time. Volume II, Parts I and II. New York: Macmillan & Co. Pp. 762 and 556. $7.50.

University School of Engineering. Laboratory of Chemistry. Pp. 23.

Virgil's Aeneid (six books) and Bucolics. Edited, etc., by W. R. Harper and Frank J. Miller. American Book Company. Pp. 564. $1.50.

Welch, George T., M. D. Therapeutical Superstition. Pp. 29.

Werner, E.. "Clear the Track." New York: The International News Company. Pp. 319. 50 cents.

Wright, Carroll D. The Phosphate Industry of the United States. Pp. 145.—Wright, Carroll D., and Gould, E. R. L. The Gothenburg System of Liquor Traffic. Pp. 258.—Washington: Government Printing Office.

Xenophon's Anabasis (seven books), edited by W. R. Harper and James Wallace. American Book Company. Pp. 575. $1.50.

Zirret, Alexander. An Elementary Treatise on Theoretical Mechanics. Part I, Kinematics. New York: Macmillan & Co. Pp. 161.

POPULAR MISCELLANY.

The World's Congress on Geology.—This auxiliary of the Columbian Exposition occupied the week August 21st to 26th, having a large attendance of geologists of the United States and Canada, with a few from other countries, though many papers were sent to the Congress by foreign geologists. The sessions were held only in the forenoons, leaving the afternoons for attending the World's Fair. Forty papers were presented before the Congress, of which thirteen were by women who are teachers and special students of geology, three of these being from

England, one from Belfast, Ireland, three from Massachusetts, two from Ohio, two from Illinois, and one each from Iowa and Colorado. Of the twenty-seven papers by professional geologists, twelve were from the United States and three from Canada, the twelve others being as follows: from Brazil, two; Venezuela, one; England, Scotland, and Germany, each two; and Sweden, Norway, and Switzerland, each one. Besides the formal papers, interesting discussions followed, and the programmes for three of the days ended with questions for special discussion, these being, Are there any natural geological divisions of world-wide extent? What are the principles and criteria to be observed in the restoration of ancient geographic outlines? and similarly, What are the principles and criteria to be observed in the correlation of glacial formations in opposite hemispheres? Among the geologists present at this Congress were Prof. Dr. Groth, of Munich; Mr. Hjalmar Lundbohm, of Stockholm; Dr. A. R. C. Selwyn, Director of the Geological Survey of Canada; the venerable Prof. James Hall, whose work in geology began sixty years ago; Profs. Le Conte, Chamberlin, Salisbury, Lindahl, Walcott, H. S. and G. H. Williams, N. H. Winchell, G. F. Wright, and many others from the United States.

Subdivisions or Unity of the Glacial Period.—The final day of the World's Congress on Geology was devoted to papers on the Glacial period, of which eight were presented. Brief notes of these papers and of the ensuing discussions will be of popular interest, as they all were specially directed to the recently much debated question whether the ice age comprised two or several glacial epochs, separated by warm intervals, as has been urged by Croll, Geikie, Wahnschaffe, Penck, De Geer, Chamberlin, McGee, and others, or was a single and continuous period of glaciation, as maintained by Dana, Wright, Upham, Lamplugh, Kendall, Falsan, Holst, Nikitin, and others.

The first paper of this series was by Prof. James Geikie, of Scotland. This distinguished glacialist concludes, from his observations in Great Britain and their correlation with the northern drift-covered portion of continental Europe, that no less than five distinct glacial epochs are recognizable there, separated by long times of interglacial temperate climate. These alternations are held to be in accord with Dr. James Croll's astronomic theory of the causes of the Ice age, affording indeed a demonstration of the truth of that theory.

Mr. Hjalmar Lundbohm, of Sweden, giving the results of his own studies and of the more extended observations of Baron De Geer in that country, thought that good evidence is found for two epochs of ice accumulation and drift deposition. During the first glaciation the Scandinavian ice-sheet flowed outward over the northwestern half of Russia and the northern half of Germany, while southwestward it covered the basin of the North Sea and was confluent with the British ice. The later glaciation, in which a great ice-lobe stretched south and southwest over the basin of the Baltic Sea, formed conspicuous moraines in Finland, northern Germany, and southern Sweden. Since the retreat of this ice-sheet Scandinavia has been differentially uplifted to a maximum amount of about one thousand feet in the center of the peninsula, and the Baltic Sea has been alternately open to the ocean and closed from it, so that for some time it was a fresh-water lake.

Mr. Andrew M. Hansen, of Norway, also declared in favor of two glacial epochs, each of them including two or more stages of ice advance and retreat. The glacial drift of Norway, however, was described as affording little testimony of an interglacial epoch, which this author accepts from its stratified deposits underlain and overlain by till in other parts of Europe.

Dr. Albrecht Heim, of Switzerland, from the glacial drift with intercalated beds containing lignite coal and plentiful plant remains in valleys of the Alps, confidently asserted that the glaciers must three times have advanced far beyond their present limits. The second advance was the farthest, and was doubtless contemporaneous with the maximum extension of the ice-sheets of Scandinavia and Great Britain.

Dr. Robert Bell spoke of the glaciation of Canada, which was wholly enveloped by the North American ice-sheet, excepting a tract west of the lower Mackenzie Valley and perhaps a narrow area adjoining the east

side of the Rocky Mountains in Alberta. The stratified beds, some of them fossiliferous, and others containing layers of lignite, which are found in Canada between deposits of till, may probably be explained by moderate advances of the ice-sheet interrupting its general recession, not so prolonged nor important as to be called interglacial epochs.

Prof. T. C. Chamberlin reviewed the history of the Ice age in the United States, concluding that it has probably a threefold division. Two long glacial epochs had preceded the chief time of deposition of the loess, which was followed by the principal interglacial epoch with retreat of the ice border perhaps generally to the northern line of the United States. The last great ice advance and stages of its retreat were attended by the formation of the remarkable marginal moraines, ten to twenty in order from south to north, which have been mapped across the northern United States and portions of Canada, while others doubtless remain to be traced in regions farther north.

Mr. Warren Upham noted the uniqueness of the climatic conditions of the Ice age, and the absence of glacial periods from the far longer Tertiary and Mesozoic eras. So exceptional climate during the Quaternary era must have resulted from very unusual causes, which could not be astronomic, for in that case records of frequently recurring general glaciation would be found in the long preceding eras. Great uplifts of glaciated countries to such altitude that they received snowfall instead of rain during all the year are regarded as the cause of the ice accumulation; but the vast weight of the ice-sheets finally depressed the land, bringing on a warm climate by which the ice was at last rapidly melted away. Only one epoch of glaciation, with fluctuating advance and recession of the ice, is held to be a sufficient explanation for the observed glacial phenomena of both North America and Europe; and the Glacial period in each of these continents appears to have ended only some six thousand to ten thousand years ago.

Mr. Frank Leverett described the diverse deposits of the older drift in northwestern Illinois, showing on a map of that State the courses of the glacial boundary and retreatal moraines which he has traced. Comparison of the depths of stream erosion in the older and newer drift indicates that their times of formation were divided by a much longer interval than the time from the end of the Ice age until now.

In the discussion following these papers, Prof. G. F. Wright spoke of the rock gorges eroded by the Delaware, Susquehanna, and upper Ohio Rivers below the highest drift-gravel terraces. This erosion has been referred to an interglacial epoch, but he finds evidence that it was preglacial, and that the valleys were filled with the early drift gravels from their present bottoms to the level of the high terraces. The general parallelism of the drift boundary and the successive retreatal moraines is thought to imply the formation of all the drift during a single epoch.

Prof. R. D. Salisbury cited the much deeper oxidation and leaching of the older than of the newer drift as proof of their widely different ages, separated by a long interval of ice departure and mild climate.

Major C. E. Dutton objected to the extension of theories beyond the warrant of facts observed. He thought it too early at the present stage of investigations to decide the causes of the Ice age; but he doubts the astronomic theory, and looks rather to geographic conditions.

Lack of time prevented the consideration of the subject assigned for special discussion, on the correlation of glacial formations in opposite hemispheres, which, however, had been more or less touched upon by several of the papers. The prevailing view seemed to be that the glaciations of Europe and America were nearly or quite at the same time, and that there was a close agreement in the sequence of events constituting the Ice age on both continents.

The World's Fair Model Library.—The model library of five thousand volumes shown by the American Library Association at the World's Fair is to be sent to the Bureau of Education at Washington for use and exhibition. This library marks a noteworthy step in advance in the choosing of books—in each department the selection was committed to an authority in his field. In the sections of electricity, photography, general political economy, and American government, lists were printed, each title being followed by a note of description and appraisal

from an eminent teacher. This method, were it applied to the whole working literature of education, would place the judgments of the best teachers at the service of all the people. Of the catalogue of this library the Bureau of Education is printing twenty thousand copies.

Thickness of Oil Films.—From experiments made in the Baltic Sea off Greifswald, Prof. Oberbeck, of the University of Greifswald, has found that the surface of water calmed by one litre of rape-seed oil or machine oil oscillates around nineteen thousand square metres, indicating that the thickness of the film is about one twenty-thousandth of a millimetre. The oil doubtless extends also in an imperceptible film outside of the circle of calm, whence the average thickness of this inner layer is probably even less. The author has made skillfully devised series of laboratory experiments to determine still more precisely the minimum thickness of a perceptible film, and found it to be two millionths of a millimetre. This is the same thickness as that which Lord Rayleigh found adequate to arrest the movements of camphor. Mr. Röntgen has also found that the vapor of ether striking upon oil scatters it till it is reduced to the same thinness. According to Herr Oberbeck, a film six times thinner is still coherent. If the quantity of oil is gradually increased the pellicle becomes more and more resistant, and of uniform thickness. When it reaches eighteen millionths of a millimetre, the oil collects in droplets which rise above the rest of the surface; and the film does not become uniform till enough oil has been poured on to equal the entire thickness of the droplets.

Advances in the Dairy Industry.—At the Dairy Building at the World's Fair there were daily demonstrations of the best modern practice in butter and cheese making. Prof. S. M. Babcock, of the University of Wisconsin, the chemist in charge, as part of his apparatus, employed the milk tester invented by him in 1890. This tester is used by adding to milk an equal quantity of sulphuric acid of 1·82 or 1·83 specific gravity. The mixture is poured into a series of glass bottles, each drawn out at the neck as a narrow and calibrated tube; the bottles, laid in an inclined position on a frame, are rotated 700 to 1,200 times per minute; the sulphuric acid separates the fat, and this fat, by centrifugal motion, is sent up into the calibrated tubes, where it is easily read off. This test places the dairy industry upon a business footing, and not only enables the proprietor of a butter or cheese factory justly to appraise the milk he buys, but also decides for the dairyman which of his cows is most profitable and which should be sent to the butcher. The importance of this simple and ready test is evident when we learn that in Wisconsin alone there are 1,700 butter and cheese factories. The Babcock tester is manufactured by some twenty firms in the United States, and by a firm in England and a firm in Germany. Due as it was to the experiments of a servant of a State, the device has not been patented. To this fact is in part due the wide sale of the tester; it is so simply manufactured that no costly patterns and plant are needed for its production; at retail the price is but eight to twelve dollars, according to size. To his forerunners in the task of fat testing Prof. Babcock declares his indebtedness. Mr. Short, of the University of Wisconsin, had invented an apparatus in which milk fat was saponified and driven forth by centrifugal motion; Prof. Patrick, of Iowa, employed, in a tester of his design, an acid instead of an alkaline combination. Uniting an idea from each of these devices, Prof. Babcock hit upon success.

Vegetarian Pedestrians.—The result of a pedestrian contest recently completed between Berlin and Vienna was a triumph for two vegetarian walkers, who came out a long way ahead of their carnivorous competitors. The fact corresponds with other evidence of the enduring power of non-meat-eaters. If there is one thing certain, says an English journal, remarking on the achievement, about the races that eat no meat, it is that they can march. "Thousands, probably scores of thousands of Sikhs and Hindostanees would have performed the German feat, and not have thought at the end of it that they had done anything wonderful; and they not only eat no meat, but they are the descendants of men who have eaten no meat for perhaps two thousand years. They have eaten wheat

or millet, and drunk plenty of milk; and they can walk rapidly as long as life remains in them. A Sepoy regiment which means it will walk a European regiment to death, and do it on food which their competitors would pronounce wholly insufficient to sustain vigorous life. A regular Hindostanee carrier, with a weight of eighty pounds on his shoulders—carried, of course, in two divisions hung on his neck by a yoke—will, if properly paid, lope along over a hundred miles in twenty-four hours, a feat which would exhaust any but the best English runners." But the writer doubts whether this power of endurance is parallel with what is called physical strength.

Hypnotism in Remedial Treatment.—An unnamed writer, whose views are pronounced by the Lancet "eminently wise and judicious," has been publishing a series of articles in the London Times on the New Mesmerism, in which he identifies the hypnotism of the French and other neurologists of the present time with the mesmerism of a former generation and the hypnotism of Braid. He affirms that denial of the existence of hypnotism is out of the question. To the inquiry whether it is sufficiently beneficial to justify its use, he replies that "a method which has been already tried and found wanting ought not to meet with the same open reception as a new remedy. What would be mere caution in the latter case very properly becomes suspicion in the former." Quoting from the old authors to show that hypnotism was practiced in former days for the same maladies and with the same alleged results as to-day, he concludes that if it had possessed a real efficacy it would never have been allowed to fall into disuse. He accepts Charcot's view that the hypnotic condition is essentially morbid and dependent on a disordered brain, and that its employment is only justifiable in a few exceptional cases here and there. The writer sums up his conclusions by saying: "Hypnotism in treatment has a real but very limited value, and it should only be used with great care. It is not likely to die out altogether, but neither is it likely to be generally adopted, or even to spread much beyond its present limits. Hypnotic experiments, unless they have the patient's benefit in view, are injurious and unjustifiable alike on the platform and in the laboratory. Finally, if I may offer any practical advice to the public, it is this: Regard hypnotism with extreme caution, and do not resort to it except on the advice of an unprejudiced medical man in whose opinion you have implicit confidence."

Tree-top Vegetation.—The plants that grow in the tops of willow trees near Cambridge, England, have been recorded during the last few years. They represent eighty species, and have been found altogether 3,951 times among about 4,500 trees. Of the eighty species, only eighteen furnish one per cent each of the whole number of records; the others occurring only in very small numbers. Classifying the plants according to means of distribution, nineteen species, of which 1,763 records, or 44·6 per cent, occur, have fleshy fruits; three species with burs were found in 651 instances, or 16·4 per cent; thirty-four species, with winged or feathered fruit, gave 996 records, or 25·1 per cent; seven plants with very light seeds, 421 records, or 19·6 per cent; and plants whose means of distribution is poor or somewhat doubtful, 120 records, or 2·9 per cent. It is thus very strikingly shown how the various mechanisms for distribution succeed, for only the better ones present any considerable numbers in the list. The bird-distributed plants appear higher here than in such cases as the flora of the churches of Poitiers, because birds visit trees more frequently. The observations show that a seed is carried only a short distance by its mechanism for distribution. Plants are always found upon the soil within two hundred and fifty yards, at most, of those found in the trees. An analysis was made as far as possible of the birds' nests found in the trees, and pieces, often with ripe fruits, of many of the plants in the list were discovered in them; so that probably this means of distribution is of some importance.

Athletics and Scholarship.—Mr. William Odell, of Torquay, England, recently addressed the question to the headquarters of some of the large public schools as to whether the boys who excel in athletics are as a rule also excellent in school work, examinations, etc. A similar inquiry made by a Mr. Cathcart ten years ago elicited an-

swers that were full of enthusiasm and unstinted praise of athletics. The replies to Mr. Odell's questions are more reserved and critical. One correspondent answered that as a general and rarely broken rule, excellence in athletics and in intellectual work are not met with at the same time in the same person; another, that "the spirit of athleticism needs controlling." Dr. Hornby, of Eton, notes that "some years ago it was quite possible for a boy who had an aptitude for cricket or rowing to attain to the highest excellence, according to the standard of that day, in athletics and school work. I doubt whether it is so now. Athletics of all kinds have become so developed and brought into a system, and, I may almost say, professional, that the time required for a very high excellence in them is, I think, a serious obstacle to a reading man or a studious boy's engaging in them with a view to athletic distinction. This is a serious evil in our day"; and Dr. Percival, of Rugby, that "the great publicity given to athletics tends to give them an undue prominence in the minds of both boys and men." These replies suggest that physical education in public schools may have been overdone and overestimated, and that the enthusiasm of a few years ago may have carried matters further than was intended.

The Glory of Columbus.—In his presidential address before the American Geographic Society on Discoverers of America, the Hon. Gardiner S. Hubbard claims for Columbus, in the face of the recent attempts to depreciate his work, all the credit that has at any time been given him. There was no map published until after the sixteenth century, Mr. Hubbard says, that gave a correct delineation of the seacoast of America. "It is no wonder that Columbus never comprehended the nature or extent of his discoveries. The more we study the history and geography of the times, the influence of the Church, the difficulty of determining longitude, the ignorance of the movements of the mariner's compass and of the distance to Cipango, the greater will be our admiration for Columbus. Yet a recent writer speaks of the discovery of Columbus as a blunder, and others say, as if in disparagement of his work, that he knew of the discoveries of the Northmen, and was only following their track; that the chart of Toscanelli, which Columbus took on his first voyage, indicated clearly his route; that Columbus died in the belief that he had discovered Cipango and Cathay, never realizing that it was the New World, and that Americus Vespucius is entitled to the greater credit." Sebastian Cabot is quoted by the author in testimony of the admiration with which Columbus's discovery was received at the court of Henry VII, where it was affirmed "to be a thing more divine than humane to saile by the west into the easte, where the spices growe, by a chart that was never before knowen." It is very doubtful if Columbus knew of the voyages of the Northmen, nor would such knowledge have been of much value, for Greenland was then believed to be a part of Europe and joined to Norway. If Columbus had known of their discoveries and sought the countries they had found, he would have sailed northwestward instead of westward. Many before Toscanelli and Columbus believed the world to be round, and that by sailing westward Asia might be reached. Columbus not only believed but proved it. He made no blunder, for he sought land the other side of the Atlantic, and he found it. Vespucius knew little more than Columbus of the New World, and never realized that North America and South America were one continent. The maps show that learned geographers long after the discoveries of Columbus, Vespucius, Cabot, and Magellan, did not understand the geography of the New World. "All voyages before that of Columbus had been coasting voyages, the sailors keeping in sight of land. Columbus pushed into the unknown and trackless ocean, leaving the land far behind. Good seamen were unwilling to undertake such a voyage, so convicts were obtained, liberated from prison on condition of sailing with Columbus. A brave, resolute, and self-contained spirit was necessary to command such a crew on such an expedition. New wonders startled him each day. . . . No voyage like that was ever made before, and none like it can ever be made again, for the great discoverer solved the problem and reached the east by sailing west."

The Pose of Egyptian Drawings.—The first thing that a Western observer remarks

in the pose of Egyptian drawings of the human figure is that it is an impossible combination according to our ideas. We see the face in profile, the eye full length, the chest in front view, and the legs sidewise. But before we condemn this as contrary to Nature, it is well, as Prof. W. M. Flinders Petrie suggests, to see what the attitude of a modern Egyptian is, and how far our notions are correct. To avoid all ideas of posing for the subject, he selects the figure of a boy from a large group that was photographed without any special aim by a Cairo dealer. In the kneeling figure are seen the profile of the face, the eye full, the chest in front view, and the legs sidewise. Everything that we have heard condemned as unnatural and impossible in the ancient sculpture is seen in the modern native, without any constraint, when simply taking an easy position. This shows what is the true ideal of the conventional Egyptian pose; it is a three-quarters view, modified by the omission of the much foreshortened parts beyond the profile—a simplification which was essential to an outline system of representation.

Variety in the Eyes of Animals.—It is hard, in studying some of the lower animals, to determine whether they have a proper sense of vision. They can all recognize light and distinguish it from darkness; but that is probably all the sight that a few organisms possess. In such creatures as earthworms, for instance, the whole skin is supposed to be sensitive to light; and there is some evidence that they have a choice between colors. Mollusks have eyes of various qualities: those of the snail distinguishing light from darkness; those of the cuttlefish very highly developed; the unique and curious eyes of the nautilus; and the two kinds of eyes of the onchidium. Some of these animals possess the power of restoring their eyes, as well as other lost members, when they are cut off. Great differences appear in the organs of sight of crustaceans. They are of all sorts, from a simple eye-spot in some species up to two compound eyes on a movable eye-stalk (as in the crab and lobster), with complete optical apparatus; and some have both simple and compound eyes. Most insects have two kinds of eyes: the large compound eye, one on each side of the head; and the ocelli, or simple eyes, of which there are generally three, placed in a triangle between the other two. The compound eyes are complex in structure, consisting of a number of hexagonal facets, each with its system of nerves. It is not known whether the combination forms one aggregate eye, or whether each facet is an eye. Many insects have thousands of these facets—some beetles as many as twenty-five thousand. The vision of scorpions, though they have six eyes, is imperfect; and that of spiders, equally well provided as to the number of ocelli, is not much better. The dexterity and unerring aim with which many reptiles catch their insect food in the air proves that they have very keen vision. The chameleon has the additional faculty of moving its eyes independently of each other, so that it can look up with one eye while looking down with the other, backward and forward, or in other different directions. The eyes of deep-sea fish are very varied: some have no eyes or sight; some have greatly enlarged eyeballs; and others are provided with phosphorescent processes or spots. Birds and many of the smaller mammals have very acute vision, while that of the larger animals is very much like our own.

Co-operation in Nature.—That crude competition is the universal law of Nature, while combination is the invention of the mind of man, is doubted by Mr. Henry Farquhar. The position, he says, is "difficult to reconcile with even the most hasty consideration of ruminants feeding in herds, where, instead of a tumultuous crowding for the occupation of the best places, we see some individuals taking posts in which they can be of service in warning the whole herd of impending danger—or of the wolves that prey upon them in co-operating packs. It is not to be rashly claimed that mind . . . is absent from the conduct of the ant and her colonies; but surely their example is convincing evidence that the lesson of the economic superiority of concert over cutthroat individual competition is one that has been well taught and learned in realms of Nature widely sundered from ours. . . . If not with man as a self-conscious being, where in the course of evolution does an implicit recognition of the wastefulness of indiscriminate competition

begin? Not even, I think, with the first appearance of gregarious animals. It is found at the point where parents first begin to care for their feeble offspring. . . . We may go back further yet—much further. It is an application of the same principle essentially unchanged when the organic cells, which are in the lower organisms independent beings, first unite in filaments to form an aggregate of the second order, each cell giving up a part of the strength with which it could carry on a rivalry with its comrades, for a power of co-operation which makes the aggregate far better able to sustain itself than as many separate rival cells could ever be."

The Biloxi Indians.—The title Biloxi, as applied to the Biloxi Indians of Louisiana, said Mr. J. Owen Dorsey, in a paper read at the American Association, was probably a corruption of the name they gave themselves, Lakes or Lakeau, meaning the first people. They lived in 1669 at Biloxi Bay, Mississippi. In 1763 they moved to Louisiana, where their number has been reduced to seventeen. Descent among them is in the female line. A Biloxi can not marry his wife's brother's daughter or his father's wife's sister, wherein they differ from the Sioux, but a Biloxi man can marry his deceased wife's sister, and a Biloxi woman can marry the brother of a deceased husband. They believed that the spirit of a deer revived and went into another body, and this could be repeated thrice; but when the fourth deer was killed the spirit never revived again. The thunder being is very mysterious and must not be talked about in cloudy weather, but only on a fair day, when thunder stories may be told. When the Biloxi see a humming bird they say that a stranger is coming; and the humming bird, they believe, always tells the truth. The crackling of the fire is supposed to be a sign of snow or rain, and a nuthatch pecking the house a sign of coming death. If a child steps over a grindstone its growth will be stopped. Snipe must not be killed or eaten, because the bird always gathers deer fat, and is the sister of the thunder being.

Playing with Electric Eels.—A writer in the London Spectator has described his experiences in handling the electric eels in Regent's Park, the largest of which is about four feet and a half long, and weighs between sixteen and eighteen pounds. "When grasped in the middle of the back, there was just time to realize that it had none of the 'lubricity' of the common eel when the first shock passed up the arm with a 'flicker,' identical with that which a zigzag flash of lightning leaves upon the eye, and, as it seemed, with equal speed. A second and third felt like a blow on the 'funny-bone,' and the hand and arm were involuntarily thrown back with a jerk which flung the water backward on the pavement and over the keeper, who was kindly assisting in the enterprise. This slight mishap recalled a far less agreeable result of a shock inflicted on a previous inquirer, whose recoiling hand had struck the assistant a severe blow in the face. Unwilling to be baffled by a fish less in size than the salmon which form the common stock of a fishmonger's window, the writer once more endeavored to hold the eel at any cost of personal suffering. But the electric powers were too subtle and pervading to be denied. The first muscular quiver of the fish was resisted; but at the second the sense of vibration set up became intolerable, and the enforced release was as rapid and uncontrollable as the first. The smaller eel was neither so vigorous nor so resentful as its fellow; but though the first and second shocks did not compel the grasp to relax, a third was equally intolerable with that given by the large fish. The electrical power seems to increase rapidly in the heavier eels." The writer thinks that the eel controls at will the power of its electrical discharge.

The Earliest Man.—In his public lecture at Madison, Wis., during the meeting of the American Association, on The Earliest Man, Prof. D. G. Brinton said that science inclined to the belief that man originated in one spot, and that all others descended from one first pair. Some eminent men of science believed that man was on the earth even in the Tertiary period. What is called the present period was divided many thousand years ago by the Glacial period; and it was probable that in certain parts of the world man lived during the ice period, which would place the antiquity of the race at least 100,000 years. Man could not have first appeared

on any small island nor in such cold regions as would expose him to death from that cause, nor anywhere where the remains of the highest animals below him were absent. This reasoning excluded Australia, all of America, South Africa, South India, northern Europe, and northern Asia. Nor did it permit the acceptance of the ancient Atlantis as that sunken land which Haeckel named Lemurea. It left only, in fact, the southern slope of that great mountain chain which began on the east with the Himalayas and extended to the farthest west of Spain. There also were found man's very oldest remains and weapons, and the oldest of them all in western Europe, in France and Spain. On the present evidence it must be said that man originated in western Europe or northern Africa. The earliest man was of the average height of men of to-day, muscular and strong, walking not always erect, but stooping forward. His skin was hairy, of a reddish color, and the women were somewhat smaller than the men. His forehead was low, but his brain was fairly well developed. He knew the use of fire, how to make weapons of stone, bone, and wood, traps for animals, and some kinds of boats. Then he used some sort of shelter; he lived in communities; he had a language; he loved his family and took care of the sick, but he did not seem to have had a religion. He was brave in battle and loved to roam. All this can be proved by a careful study of his remains. It was concluded, therefore, that the earliest men were of the same spirit and soul with ourselves, endowed with like faculties and with a similar capacity to advance.

Inheritance Taxes.—Mr. Max West, in his study of that subject (Columbia College Series in History, Economics, and Public Law), finds the recognized origin of the inheritance tax in its imposition by Augustus in Rome, 6 A. D.; but thinks it probable that the Romans borrowed the idea from the Egyptians. There are evidences that Egypt had an inheritance tax, probably of not less than a tenth, from which even direct heirs were not exempt. A papyrus has been found which relates that a certain Hermias was sentenced in a heavy penalty for failing to pay the tax on succeeding to his father's house. Another inscription records a sale of property by an old man to his sons at a nominal price, apparently for the purpose of evading the inheritance tax. Mr. West's review of the history of the tax in different countries and through its various phases leads him to the conclusion that it is pre-eminently an institution of democracy. It is found in nearly every civilized country, but it is only in the most democratic countries—Great Britain, France, Switzerland, Canada, and the Australasian colonies—that it reaches its fullest development, with high and usually progressive rates, and becomes an important source of revenue. The United States seems thus far to be an exception to this rule, but the increasing popularity of this mode of taxation, and its rapid extension from State to State, indicate that at no distant day it may be general in America. In the assessment of the tax a graduation according to relationship is nearly universal in practice. Direct heirs are in many cases exempted, and in others are taxed very lightly, as compared with collateral and distant heirs. A progression in the rate of the tax corresponding with increase in the amount of the estate is sometimes adopted. Bequests for public, benevolent, and educational purposes might well be exempted, for in such cases, if the gift is wise, the whole amount accrues for the benefit of the community. The question of what to regard as inheritances for purposes of taxation is sometimes a difficult one. A bequest of freedom to a slave has been held to be taxable. A succession is sometimes defined as any beneficial interest in property accruing in possession or expectancy on the death of any person. The English law includes interests accruing by survivorship in the case of joint ownership, by general powers of appointment, and by the extinction of determinable charges; but life insurance is excluded. That the inheritance tax is regarded as something more than a purely fiscal measure is shown by frequent proposals to use the proceeds for benevolent or educational purposes. Such proposals have sometimes borne fruit in legislation.

Fish Culture in America and Europe.—It appears from a statistical review of fish culture in Europe and North America, prepared by N. Boroline, of the Russian Association of Pisciculture and Fisheries, that the eighty

fish-hatcheries in North America (sixty-six in the United States and fourteen in Canada and Newfoundland) produced in the year of their last report 1,616,027,192 fish hatched; and four hundred and sixteen hatcheries in Europe, 277,973,016 young fish. The North American hatcheries are all governmental; most of those in Europe are in private hands. The average production of one hatchery is 668,000 in Europe and 13,400,000 in North America. In Europe the largest amount of money for fish-cultural works is spent in Germany—the most by the Deutsche Fischerei Verein. France, which has contributed more than any other nation toward the development of piscicultural work, now ranks behind several other countries. Italy has recently begun piscicultural work under the control of the Government. The appropriations for this work by the Government of the Netherlands are small, while none are made by Austria-Hungary. The appropriations of the British, Russian, and Swedish Governments are also small. "When," says Mr. Borodine, "we compare the total amount of $37,032 spent for piscicultural work by all European countries with the appropriations of North American countries, we shall not be surprised at the enormous difference in the amount accomplished in the Old and New Worlds. Europe originated and developed the methods of fish culture, but it has become an industry only in America."

NOTES.

THE Primitive Woman as a Poet was the subject of a paper at the American Association by Prof. A. F. Chamberlain. Lullabies, the author said, are known in every land, and the folk poetry of all people is rich in songs whose text and whose melodies the tender mother has herself imagined and composed. But not alone cradle-songs are the product of the genius of the woman. As in modern so in primitive times maidens inspired by love have vented their feelings in song. We find such poetesses among the Arabs and Bedouins of the desert, in Polynesia and Australia, Madagascar, etc. Women improvisators are known among the American Indians, among the African tribes, etc. The share of woman in the transmission of song and story from generation to generation is very great. Indeed, among some of the tribes of Guiana the bards of ancient times are represented as old women. Among the Bedouins as elsewhere, women and girls have special songs which are never imparted to the men, and it is very difficult, often impossible, for a traveler to obtain the text of such songs.

IN a paper on Indian Migration, read at the American Association, C. S. Wake endeavored to trace the migrations of the tribes from their traditions. An examination of these traditions, the author said, showed that besides the Algonkins, Iroquois, and the Cherokees, the people of the Sioux-Dakota stock also dwelt at an early date near the St. Lawrence. Probably all the people thus brought together in the neighborhood of the Eastern lakes had a common origin, the place of which may have been north of the St. Lawrence. The primitive long-headed Indians of North America spread originally over the continent from some part of the northwest coast, or the foreign element to which they owe their special characteristics was introduced there. This element has its nearest representative on the American continent in the Eskimo. The Eskimo skull approximates the type found among the Caroline islanders, the Fijians, and the aborigines of Australia. The long-headed tribes of North America may thus find their oldest allies among the islanders of the Pacific.

M. MAREY has found, from his continued studies of animal locomotion by means of instantaneous photography, that the modes of progression of the viper and the eel are much alike; that the postures of batrachians in water (after they have acquired their limbs) are much like those of men swimming, and that lizards trot like horses.

A PAIR of catbirds having built a nest in a honeysuckle vine on the house of Dr. R. W. Shufeldt, he took the pains to observe their nesting habits. The first egg was laid twenty-four hours after the nest was built, and three others on three succeeding days, all very nearly at the same hour in the morning (between 9.15 and 10.35). For the first few days the mother bird sat on the eggs at irregular intervals, leaving them often for an hour or more, but finally gave them her undivided attention. On the fourteenth day from the first laying there were no birds hatched at dark, but on the next morning there were three; and the fourth egg was hatched during the next night. On the twenty-fifth day all the birds left the nest together; but not going away, the young were easily caught. They were put in a cage and hung under the roof close to the nest. Here the parents faithfully fed them through the cage wires for three days, when they were let loose in some dense underbrush, to the great joy of the parents.

THE report of the managers of the Observatory of Yale University says that while only a small percentage of the thermometers sold are sent there for certification, it is presum-

ably true that those which are sent by the manufacturers are carefully selected and therefore far more reliable than the average of those sold without certification. Nevertheless, the testers are obliged to reject twenty-five, fifty, and even seventy-five per cent of those sent them. As a rule, these are not rejected without receiving double the time and care required by the large majority of those to which certificates are granted.

THE course of instruction in naval architecture recently established at the Massachusetts Institute of Technology provides for a thorough training in the theory and methods of devising and building ships, together with a study of the properties requisite for safety and good behavior at sea. It is arranged to occupy four years, and leads to the degree of Bachelor of Science. It is intended to cover the same ground and accomplish the same results as the English and French Government schools for training naval constructors, and to give, in addition to professional and technical training and equipment, a good scientific and liberal education.

HITHERTO disorders observed among workmen in hemp have been regarded as originating wholly in mechanical causes, as in the inhalation of vegetable dusts. Dr. L. Salomon, of Savigné l'Evêque, France, who has studied two cases of such disorders, attributes them to intoxication by the active principles of hemp, similar to those produced by hashish.

THE Laboratory of the Psychological Institute at the University of Göttingen—described by Prof. W. O. Krohn as in many respects the best for research work in Germany—owes its excellent equipment to a liberal gift from a private person, the state contributing only a pittance to its support. This person is a former student of Prof. Müller.

THE Report of the Division of Entomology (Bulletin No. 29) on the Boll Worm of Cotton (*Heliothis armiger*) covers in the first part observations made by Mr. F. W. Mally upon the parasites and natural enemies of the insect, and presents in the second part bacteriological experiments made by the same observer with certain insect diseases affecting it. The paper also contains observations of the depredations of the larva upon corn, and upon the use of corn as a trap for it.

THE courses of instruction in the Department of Geology of Colgate University, while designed to give such knowledge of the several subjects as a scheme of general education requires, are so arranged as to provide two years of continuous work to those who may wish to teach geology or pursue it as a profession. The instruction is given by lectures, with text-books for supplementary reading, oral and written reviews, and laboratory and field work. Besides the general collections of minerals, and in geology a dynamical collection, illustrating weathering, glacial action, the work of springs, underground waters and the ocean, the results of volcanic and mountain-building forces, the work of organisms, and various structures, with specimens illustrating lithology, and a systematic collection of fossil remains have been begun. In economic geology sample blocks of building stone have been acquired.

OBITUARY NOTES.

THE death is announced of M. Daniel Colladon, of Geneva, one of the most eminent of the former generation of physicists, in the ninety-second year of his age. He was born at Geneva in 1802; became an engineer; studied physics and mathematics in Paris; returning to Geneva, performed in co-operation with Sturm, in 1827, his famous experiments on the propagation of sound in water. The two also studied together the resistance of materials and the compressibility of liquids. In 1829 he became Professor of Mechanics in the *École Centrale des Arts et Manufactures* in Paris; later, professor in the academy at Geneva. Near the beginning of his career he studied the properties of liquid veins, and executed the remarkable experiment of the transportation of luminous waves by a column of water, which is the basis of the curious luminous fountains. One of his most important discoveries was that of the use of compressed air as a medium for the transmission of energy—a discovery which has found practical application of great value in apparatus for perforating tunnels. He was also an earnest student of meteorological phenomena, and made many observations on lightning and hail. Like most students of broad minds, he took much interest in the popularization of science.

HENRY J. PHILPOTT, a writer who had gained considerable distinction in the discussion of economical subjects, died of consumption in Niles, Cal., September 24th. He was a resident of Iowa; had been engaged in editorial work in that State; and had gone to California as a last resort for the possible benefit of his health. He was prominent in the organization of the Free-Trade movement in Iowa; was interested in the work of the Society for Political Education of this city; and published many bright and forcible papers on the subjects he held near at heart. He contributed to The Popular Science Monthly articles or letters on The Joint-Snake Idiocy (vol. xxx); Social Sustenance (vol. xxxi); Origin of the Rights of Property (vol. xxxv); Irrigation of Arid Lands, and A Novel Water-Cooler (vol. xxxvi); A Little Boy's Game with a Ball (vol. xxxvii); and Almond Culture in California (vol. xli).